Using age-progression facial morphing technology to encourage smoking cessation in women and the role of the stress response

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Abstract

Background: Women are at increased risk from smoking and experience specific barriers to smoking cessation. Age-progression interventions that demonstrate the ageing effect of smoking to the face, appear to be effective in changing smoking intentions and behaviour in women. One underlying theme of age-progression research is a shock reaction that is thought to create stress reactivity. The impact of this shock response on efficacy of the intervention has yet to be understood.

Aim: The research within this thesis aimed to investigate the effectiveness of an age-progression intervention for smoking cessation in women aged 18-55 years, and the role of the stress response elicited by the intervention on smoking outcomes.

Methods: A systematic review updated and synthesised information regarding the effectiveness of appearance based interventions. A mixed methods approach was used in a pilot study, to develop aspects of research design, including the use of physiological stress measurement and intervention instruction types (Neutral and Reassuring) to influence levels of stress. A qualitative investigation also explored the experiences of women who received the intervention. Findings from the pilot were implemented in a randomised controlled trial that assessed the impact of psychological and physiological stress induced by the intervention and its impact on the long-term smoking outcomes.

Results: Qualitative study indicated the age-progression technique continues to create shock, with more instances of accounts of shock reported by women that received the Reassuring instructions. The quantitative study showed this response was accompanied by an increase in subjective and physiological stress. Lastly, findings from the randomised controlled trial indicated the age-progression intervention delivered using Reassuring instructions produced changes in smoking intentions and abstinence. Importantly, stress elicited by the intervention, positively moderated intentions to quit.

Conclusions: The synthesised findings from this thesis conclude that age-progression interventions for smoking cessation can reduce smoking behaviour in women. Additionally, when administered via Reassuring instructions, high levels of short-term stress can increase the effectiveness of the intervention. Future research should

focus on identifying the optimal stress levels induced by smoking cessation interventions that increase successful smoking cessation.

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List of Abbreviations

Abbreviation	Definition
ACTH	Adrenocorticotropic hormone
ANS	Autonomic Nervous System
CBT	Cognitive behavioural therapy
CO	Carbon monoxide
CONSORT	Consolidated Standards of Reporting Trials
CRH	Corticotrophin releasing hormone
E	Epinephrine
EDA	Electrodermal activity
EPPM	Extended Parallel Process Model
fMRI	Functional Magnetic Resonance Imaging
GABA	Gamma aminobutyric acid
GAS	General Adaption Syndrome
HADS	Hospital Anxiety and Depression scale
HPA Axis	Hypothalamic pituitary adrenal axis
HR	Heart Rate
ITT	Intention to Treat
MBSRQ	Multidimensional Body-Self Relations Questionnaire
NAc	Nucleus accumbens
nAChRs	Nicotinic acetylcholine receptors
NaCl	Sodium Chloride, or Chloride salt
NE	Norepinephrine
NS-SCR	Non-specific skin conductance response
OC	Oral contraception
PBC	Perceived behavioural control
PMS	Premenstrual syndrome
PMT	Protection Motivation Theory
PPG	Pulse Plethysmograph
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PSS	Perceived Stress Scale

RCT	Randomised Controlled Trial
SAM pathway	Sympatho-adrenal-medullary pathway
SES	Socioeconomic status
SN	Subjective norms
SNS	Sympathetic nervous system
VTA	Ventral tegmental area
WCS	Weight Concern Scale
WGC	Weight gain concern

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Appendices

1 Chapter 1: General introduction

1.1 Context of the thesis

This thesis provides an investigation of an age-progression intervention for smoking cessation, implemented within women. The age-progression intervention being investigated captures a photograph of an individual's face. Through facial morphing technology the photograph is used to show a simulation of how the individual is likely to age up to age 72 years, with and without the effects of smoking on the skin. The intervention has been investigated prior to this thesis through quantitative and qualitative approaches, results indicated the intervention can be effective in changing smoking intentions and behavior in smokers (Flett et al., 2017; Grogan et al., 2011; Grogan et al., 2010b). Qualitative research specifically reported that the intervention creates a shock reaction in women, and it was suggested that this shock reaction could be related to the effect of the intervention on smoking behaviour (Grogan et al., 2010b). The current thesis, through a series of qualitative and quantitative investigations therefore sought to develop and execute research that could measure stress reactivity in response to the intervention. Additionally, to explore the influence of the stress measured in response to the intervention, on smoking outcomes.

This thesis is comprised of one systematic review, and two data collection time points resulting in three connected investigations, all of which were conducted to achieve the thesis aims (set out in Chapter 4). Firstly, in order to identify the previous appearance based interventions used for smoking cessation, literature was explored and an updated systematic review of appearance based interventions for smoking cessation was produced. Details of the literature, the search criteria and systematic review findings are outlined (Chapter 3). After identifying the current literature findings and limitations, the first study (pilot), was developed to test the feasibility of the research design needed to perform a randomised control trial to assess the impact of the age-progression intervention or control arms on smoking outcomes, and investigate the impact of subjective and physiological stress, measured at baseline and during the intervention. As part of the pilot, qualitative research methods and findings were used to develop the protocol (reported in Chapter 6). While quantitative components of this pilot investigation investigated the levels of stress induced via the intervention instructions in addition to levels of participant attrition, (Chapter 8). As an additional element to the thesis, qualitative methods were also used to explore the experiences of women who received the intervention using data retrieved within the pilot session. This research added to our understanding of previous qualitative research findings, by including a diverse age range of women and examining the experience of the intervention

in today's technology focused context (Chapter 7). Lastly, the third study was a randomised controlled trial (RCT). This study implemented information gained from the pilot investigation in order to investigate the impact of the age-progression intervention and control arms on smoking outcomes, measured immediately afterwards and at longitudinal time points. The RCT also investigated the impact of the conditions on the subjective and physiological stress response, and how this response impacted the intervention outcomes (Chapter 9). All of the studies are outlined in detail, including focused information regarding background, results and discussion. Accompanying the main research are chapters regarding the surrounding literature, methodologies chosen and a general discussion. A brief overview of the structure of the thesis as a whole is provided below.

1.2 Chapter 2-9 summaries

1.2.1 Chapter 2. Literature review

This chapter provides an introduction and summary of the key issues and topics covered throughout the thesis chapters. The prevalence and impact of smoking behaviour is firstly introduced and discussed in relation to women and health, highlighting the need of interventions for women. Given the impact of stress on smoking behaviour, literature on stress and smoking is then outlined and the role of stress within smoking interventions is discussed. The role of barriers to smoking cessation are considered for their potential influence on behaviour and intervention success in women, including the links between appearance and smoking and its influence on smoking behaviour.

1.2.2 Chapter 3. Physical appearance and smoking. A review of the literature and systematic review of appearance based smoking interventions.

Chapter 2 identified physical appearance as a potential target to motivate women behaviour change. Chapter 3 reviews the literature related to appearance and appearance concerns as a tool for smoking cessation. A systematic review of appearance based interventions for smoking cessation was then conducted, updating a previous review that considered research up to 2012. Eleven electronic databases were searched from the 1st of January 2012 to the 22nd of May 2018. Abstracts, keywords and titles of publications were searched using a search strategy adapted from Flett's et al. (2013) review, for improved accuracy of the search. Six papers met the inclusion criteria. As the heterogeneity of the interventions prevented performing a meta-analysis, a quality assessment of the papers and a narrative synthesis was conducted. The results from the selected papers are summarised and appraised, and guidance on how research on appearance based interventions can be improved is

provided. Shock and stress were identified as a dominant theme within the qualitative research and therefore potential impacting variables on the intervention outcome.

1.2.3 Chapter 4: Thesis rationale and aims.

This chapter provides the rationale that underpins the overall aims and structure of the thesis, the inclusion of stress measurements, the mixed methods approach and development of verbal instructions that were aimed to either maintain (Neutral instructions) or decrease (Reassuring instructions) the stress experienced during the intervention. The structure of the related empirical chapters of the thesis are also explained. Lastly, the chapter is concluded by outlining all the aims and objectives for the individual studies within this thesis, which will be referred to in later chapters.

1.2.4 Chapter 5. Methodology

The methodological and epistemological approaches used within this thesis are detailed within this Chapter. The use of a mixed method approach (including both, quantitative and qualitative methods) is argued to be a suitable design for thesis research allowing for a comprehensive investigation of the subject. The mixed methods use of qualitative methods to inform quantitative approach, was applied to allow for the development and progression of research design. The individual components and materials used in both qualitative and quantitative aspects of the research are described in detail including the use of physiological measures, and the age-progression intervention implemented within both the pilot (Chapters 6 and 8) and RCT (Chapter 9) studies.

1.2.5 Chapter 6. Protocol development

Chapter 6 presents the findings of the qualitative component of the pilot. Thirty women were recruited to engage with the age-progression intervention, using one of two intervention instructions (Neutral designed to maintain the stress experienced or Reassuring designed to reduce the stress experienced). Aspects of the interview guide were developed to assess how the participants felt the study protocol could be improved. Responses from the participants were assessed and identified improvements were added to the protocol in stages, with the final protocol designed implemented in the final study (RCT).

1.2.6 Chapter 7. Exploration of women's experiences engaging with the age-progression intervention

Chapter 7 presents additional qualitative findings that assessed the experiences of women who received the age-progression intervention. Interview questions allowed for the explorations of participants experiences of the intervention. Differences between participants administered the instruction types (Neutral or Reassuring) were observed within the themes identified from interview transcripts, indicating Reassuring instructions induced more accounts of shock in comparison to Neutral. The findings were related to those of previous research and health psychology theory.

1.2.7 Chapter 8. Quantitative pilot findings

The quantitative findings of the pilot investigation provided information regarding i) the physiological arousal elicited by the intervention and instruction conditions, ii) levels of attrition assessed from follow up data collection time points ranging from 1- to 6-months and, iii) as the study was a pilot investigation, preliminary exploratory analysis were performed on smoking outcomes. Findings suggested that age-progression intervention i) increased stress response, with the impact of instruction types mirroring qualitative accounts and ii) reduced smoking behaviour. Information obtained from attrition assessment and exploratory results were then implemented into the design of the RCT.

1.2.8 Chapter 9. Randomised controlled trial.

The final empirical chapter within this thesis presents the design, implementation and findings from a three arm parallel groups RCT, investigating the age-progression intervention delivered to women between the ages of 18-55, and the assessment of the role of the stress response. The study design incorporated developments and suggestions from, the systematic review (Chapter 3) findings, in addition to the suggestions drawn from the protocol development in the pilot investigation (Chapters 6 and 8). The RCT examined the efficacy of the intervention delivered via the instruction type arms (Neutral and Reassuring) in addition to a control intervention comparison. Smoking outcomes were examined over longitudinal time points of 1-, 3- and 6-months post-intervention delivery in order to determine the long-term efficacy of the intervention conditions. The impact of the stress response on intervention outcomes was assessed for each longitudinal time point. Results indicated the Reassuring instruction condition had superior smoking outcomes in comparison to controls and reported the highest levels of psychological stress which

positively influenced smoking outcomes. The findings were discussed in relation to behaviour change models of fear and persuasion.

1.2.9 Chapter 10. General discussion

Chapter 10 provides a summary of the main findings of the thesis and emphasises the links between the individual empirical studies and the previous research. It was concluded, that when combined, results from this thesis indicate age-progression interventions for smoking cessation could be made more effective through the addition of instructions designed to induce stress. These novel findings suggest that increased stress induced through reassurance instructions in relation to the intervention images could create positive changes in smoking behaviour. It is recommended that future research continues to investigate the optimal delivery and corresponding stress response to accompany age-progression interventions and develops avenues of research exploring the online capabilities of the approach. Limitations do exist in the studies regarding the homogeneity of the participants and stress measures. Despite these limitations, the current thesis makes significant contributions in expanding our knowledge of age-progression interventions for smoking cessation and the role of stress in interventions for behaviour change.

2 Chapter 2: Literature review.

2.1 Introduction.

Chapter 1 provided an overview of this thesis. This second chapter introduces a comprehensive literature review covering relevant topics related to the research outlined in later chapters. Topics include i) the prevalence and impact of smoking behaviour in relation to women and health, ii) the role of stress in relation to smoking iii) smoking intervention success and, iiii) the links between appearance and smoking behaviour within women. The chapter provides context for the thesis research and leads to a systematic review (Chapter 3) that specifically synthesises the effectiveness of appearance based interventions for smoking cessation.

2.2 Smoking and Health

2.2.1 Impact of tobacco smoking on health

Tobacco contains over 4000 chemicals, including carcinogenic and harmful chemicals; such as the chemical ammonia and more commonly associated chemical with smoking such as carbon monoxide (Shorrock and Bakerly, 2019). This mix of chemicals can cause several smoking related illnesses and deaths. Smoking tobacco is estimated to be the leading cause of preventable death, with an estimated 77,600 deaths per a year between 2016 and 2018 in the UK (Office for National Statistics, 2020). Smoking is also widely known to contribute to the development of a wide range of cancers. Cancer Research UK (2018b) states smoking causes at least fifteen different types of cancer, with the impact not limited to common well-known smoking-related cancers such as lung and throat, but also other type of cancers, such as bladder, kidney and cervix. Cancer Research UK reported that smoking is the cause of three in twenty cases of cancer in the UK alone (Cancer Research UK, 2018b).

In addition to cancer, smoking contributes to the development of a number of smoking related diseases and medical complications (Shorrock and Bakerly, 2019). Smoking affects a number of bodily systems including respiratory, cardiovascular, haematology, wound healing and bone health (NHS, 2018). These systems are affected both pathophysiologically through disease, and perioperatively through complications such as secondary disease or negative reactions after surgery (Shorrock and Bakerly, 2019).

Women have specific risks to health as a result of inhaling tobacco smoke. The effect of smoking on the risk to developing specific health conditions is higher for women than in men. Women who smoke are 25% more likely to have coronary heart disease than males

(Huxley and Woodward, 2011). Women sex-specific cancers (e.g., breast cancer) are also increased among former and current smokers (Luo et al., 2011). Smoking, even at low levels, has also been found to impact female fertility and is related to higher rates of ectopic pregnancies and reduced success rates in fertility treatments (Action on Smoking and Health, 2018).

In addition to the direct impact smoking has on health at the individual level, smoking also has wider implications for public health. Passive smoke, also known as environmental tobacco smoke, causes a range of negative health effects. Toxic chemicals, such as ammonia are found in high concentrations around smokers and can be inhaled deeply into the lungs of passers-by (DiGiacomo et al., 2019). In a review of meta-analyses on observational epidemiological evidence for the health effects of tobacco smoking, Cao et al. (2015) revealed a significant relationship between exposure to environmental tobacco smoke and risk of eleven diseases (including five different types of cancer, childhood specific diseases and conditions, allergy development, invasive diseases and lifelong conditions).

As well as the health problems caused to the self and others through tobacco smoke, smoking causes economic burden on society in general. The World Health Organisation (WHO) estimated that smoking causes over US$500 billion in economic damage, due to excess healthcare costs and lost in productivity (World Health Organisation, 2017). A review of the economic impact of smoking (Ekpu and Brown, 2015) highlighted that in the US the direct effects of smoking on health care expenditure ranged from 6% to 18% across the country, whereas in the UK the National Health Service (NHS) is estimated to spend between £2.7 billion and £5.2 billion per a year on smoking related costs, equating to 5% of the NHS total budget.

A study in 2010 (Ekpu and Brown, 2015) estimated the indirect costs of smoking in the UK, (loss in productivity, increased absenteeism, cleaning up cigarette butts, costs of fires caused by smoking, loss in economy due to death of smokers and passive smoking). When summed the costs equated to a figure around £11 billion. It should be acknowledged there are obvious economic interests and benefits derived by tobacco, such as revenue from tax and jobs created. However, as the Ekpu and Brown (2015) review points out, this benefit is offset by the direct costs of smoking on society and socially desirable outcomes, such as productivity of the work force.

2.2.2 Prevalence of tobacco smoking.

According to a recent Office for National Statistics report (Office for National Statistics, 2019), 14% of the adult population are current smokers, above the current national government target of 12% or less (2019). Since 2011, the number of smokers has declined in England, Scotland and Wales (Office for National Statistics, 2020). The likelihood of being a smoker is highest within the younger population, ages 25-34. Smoking prevalence in pregnant women has also dropped in recent years (Action on Smoking and Health, 2018). However, given the additional harm that smoking causes to the unborn baby, smoking cessation during pregnancy continues to be a major public health priority (Department of Health UK, 2017).

The government allocates regular funding to smoking cessation campaigns in an attempt to reduce smoking prevalence, yet evidence to suggest these campaigns contribute to the falling number smokers in the UK is still scarce. Kuipers et al. (2018) investigated the association between mass media campaign expenditure and quit rates, showing that monthly spending on mass media campaigns ranged up to £2.4 million, with each 10% increase in spending relating to 0.51% increase in successful quit attempts. This finding indicates that expenditure on mass media may contribute to, but not play a large role in decrease of smoking in the UK. While mass media campaigns may not have a big impact on smoking reduction, research evidence suggest that changes in policies may be more effective in contributing to the reduction in smoking prevalence in the UK. The Tobacco Control Scale (TCS) is used to quantify tobacco control policies implemented across Europe. Countries with a higher score in TCS have lower prevalence in rates of smokers in the last ten years, with a positive relationship observed between TCS score and quit ratios (Feliu et al., 2019b).

In addition to tobacco control policies, stop smoking services have been found to contribute to the decrease in smoking prevalence. Song et al., (2018) used modelling techniques to estimate how stop smoking services provided by the NHS contributed to a 15.1% reduction in smoking prevalence from 2001- 2016. Quit attempts using stop smoking support had a higher chance of success than those attempts without NHS support (Song et al., 2018).

Statistics indicate that over half of current smokers have intentions to quit, whereas only 30-40% of them progress to make a quit attempt (Office for National Statistics, 2019). In places where smoking prevalence has declined, smokers that remain have been suggested to harden. The hardening hypothesis proposes that less addicted smokers, are more likely to quit

leaving behind the hardened population (Feliu et al., 2019a). Evidence suggests hardening occurred in the UK, indicating that tobacco control measures have not greatly affected motivation to quit (Docherty et al., 2014). However, the hypothesis should be viewed with caution, as some authors indicate there may not be enough convincing evidence to support this trend (Edwards, 2019).

The Department of Health has stated their goals are towards a smoke free generation in the UK, with the aim of progressively reducing smoking prevalence to 12% by 2022 (Department of Health UK, 2017) and becoming smoke free by 2030 (Office for National Statistics, 2020). Stop smoking services have been effective in the UK in increasing quit rates (Song et al., 2018). New approaches to smoking cessation could therefore be developed to increase motivation to quit, promote attendance at stop smoking services, or to be incorporated into existing and new services mostly targeting individuals more resistant to quit.

2.2.3 Nicotine dependence

Smoking rates although reduced, are still above the national target for the UK. If smokers are given support, they are indicated to have a higher chance of quit smoking success (Song et al., 2018). Stop smoking support could therefore contribute to reducing the addiction to tobacco (Jha et al., 2006). Nicotine is the main psychoactive ingredient in tobacco and a contributor to tobacco addiction and the maintenance of smoking behaviour, through inducing feelings of reward and pleasure in the brain (Markou, 2008).

Nicotine is a chemical alkaloid that is naturally produced in the tobacco plant (Benowitz, 2009). When smoked, nicotine is distilled from the tobacco and transported to the lungs, and via absorption into the circulatory system reaches the brain (Benowitz, 2009). In the brain, nicotine binds to nicotinic acetylcholine receptors (nAChRs), these receptors are ligand-gated ion channels with the biological neurotransmitter of acetylcholine (Laviolette and van der Kooy, 2004). Brain stimulation induced by nicotine binding to nAChRs results in release of several neurotransmitters, including dopamine (Arias-Carrión et al., 2010).

The dopaminergic pathway in the brain is one of the main neurobiological structural pathways involved in drug addiction (Lemieux and al'Absi, 2016). In particular the mesolimbic pathway has been related to nicotine dependence (Benowitz, 2009). The mesolimbic pathway consists of cell bodies in the ventral tegmental area (VTA) and axons

spread towards the nucleus accumbens (NAc). When dopamine increases in the NAc due to nicotine administration, the mesolimbic brain pathway that regulates feelings of reward and pleasure is stimulated (Perez-Rubio et al., 2015). Glutamate, γ-aminobutyric acid (GABA) is responsible for providing inhibitory input to VTA dopaminergic neurons, reducing the level of dopamine (Arias-Carrión et al., 2010). When smoking behaviour continues, a large amount of dopamine is released, the nAChRs that are associated with GABA are desensitised, leading to long-lasting excitation of dopamine neurons due to the removal of inhibitory influence of GABA (Laviolette and van der Kooy, 2004). Prolonged exposure to increased levels of dopamine in the NAc leads to tolerance (neuroadaptation) to the effects of nicotine (Benowitz, 2009) producing compulsive use of nicotine and dependence (Govind et al., 2009) often in the form of cigarettes and other smoked tobacco products.

2.3 Smoking and stress

The general belief of tobacco consumers is that smoking reduces their levels of stress (Shadel and Mermelstein, 1993); however, as it will be explained below, the relationship between stress and smoking behaviour involves complex behavioural, psychological and physiological interactions.

2.3.1 Overview of the stress response.

2.3.1.1 Definition of stress, stressors and the stress response.

Stress is a popular construct within literature, its definition often varies due to its multidimensional nature (Le Moal, 2007). Walter Cannon first made a series of investigations of the adaption responses of animals when exposed to a multitude of stimuli (Cannon, 1929). These adaptive responses included bodily changes as well as strong emotions, Cannon noted that the adaptions allowed the mobilisation of energy (Cannon, 1929). Cannon proposed the paradigm of "fighting-or-flight" (Cannon, 1929), known today as the fight or flight response to stressful situations, in which the mobilised energy is used in order to react to or flee the stressful situation. Cannon also coined the term homeostasis, describing the ideal state of bodily function to maintain cell function (Cannon, 1929). Both the concepts of the fight or flight response and homeostasis contributed to the foundations of understanding stress.

Influenced by Cannon's work, Hans Selye in 1936 proposed the 'general adaption syndrome' (GAS) theory, characterised by a number of non-specific physiological responses (Selye, 1936). Selye categorised these responses into three stages 1) alarm, 2) resistance 3)

exhaustion. The stages present how humans and other animals are initially alarmed by a stressor, before homeostasis is restored and the individual is able to adapt or defend against the influence of the stressor. However, if this stressor persists exhaustion may follow, and the organism becomes vulnerable to illness or death. From GAS the concept of stress from a biological perspective was proposed (Selye, 1950).

At the same time the theory of GAS (Selye, 1936) was the dominant theory, Richard Lazarus began his research investigating the role of individual differences and coping strategies within the stress response (Lazarus and Eriksen, 1952). Lazarus (1966) proposed the cognitive-motivational-relational theory in which individuals cognitively appraised the stressful environment and used one or more coping strategies in attempt to adjust to the situation. Within this response, individual differences and predispositions played a key role in the individual's response. Therefore, the concept of stress was broadened and was a more useful concept for clinicians to use, as it helped to focus on the individual, while most previous research at the time focused instead on general laws of responses (Robinson, 2018).

Over the years, researchers have revised the concept of stress (McEwen and Stellar, 1993; Schulkin et al., 1994). Compared to the initial work of Cannon in which the term homeostasis refers to the whole body function, McEwen applied the concept of homeostasis only to the maintenance of a limited number of physiological variables such as body temperature and glucose levels (McEwen, 2005). Additionally, the concept of 'allostatic load' was proposed advancing on the notion of homeostasis (Cannon, 1929). Allostatic load however is a reinterpretation of Selye's third stage of GAS 'exhaustion' (Selye, 1950) as growing evidence indicate that stress has both damaging and protective effects (for review see McEwen (2006)). Short term biological reactions to stress have a protective influence on the body whereas repeated or sustained stress can often lead to dysregulated reactivity of the stress system, producing blunted, heightened or prolonged responses to stress (McEwen and Wingfield, 2003). Recognition of the dual nature of stress has led to the development of new terminology that links the protective and damaging effects of the biological response to stress. This definition of allostasis goes beyond the restrictive definition of Cannon's 'homeostasis' by allowing for a more encompassing view of how biological stress responses are involved in daily life and lead to cumulative negative effect only when stress responses are mismanaged or overused (McEwen and Wingfield, 2003).

Theories on stress have evolved over time incorporating findings from a growing body of research, using sophisticated advanced technologies as they become available. Research into the physiological stress response, as outlined below, indicates different pathways of response depending, among other factors, on i) the characteristics of the stressor (Godoy et al., 2018), ii) previous stress experience of the organism and predecessors (Yehuda et al., 2015; Marquez et al., 2013), iii) developmental stage and age of the individual (Haigis and Yankner, 2010; de Kloet et al., 2005b), and iv) specific biological characteristics, such as, e.g. sex (Lundberg, 2005; Schechter et al., 2015).

2.3.1.2 Physiology of the stress response

The body produces different types of physiological responses depending on the type and length of a stressor. When a physical stressor is present, or a situation is perceived as stressful, the sympathetic nervous system (SNS) is activated, in which organs and glands such as the heart are directly activating increasing heart rate, in addition the hypothalamus activates the Sympatho-Adreno-Medullary (SAM) system of the autonomic nervous system (ANS). This system triggers the rapid secretion of the epinephrine (E) and norepinephrine (NE) from the adrenal medulla and in the brain (de Kloet et al., 2005a; Kvetnansky et al., 2009) and NE from sympathetic nerve terminals (McCorry, 2007; Kvetnansky et al., 2009). Epinephrine is released peripherally into the blood and binds to adrenergic receptors on peripheral tissues such as the heart and the lungs, inducing immediate emergency responses, causing physiological changes that prepare the body for "fight-or-flight" reactions (Cannon, 1929). These physiological reactions include rise in blood pressure, sweat and increased heart rate (HR) (Bitsika et al., 2014). These responses maintain alertness and prepare the body to respond to the stress experienced (Godoy et al., 2018). Blood concentrations of E and NE rise to peak levels after 15-30 minutes and then slowly decline to levels observed before the stress response around 60-90 minutes later (Christensen et al., 2020). Under normal conditions the parasympathetic branch of the ANS is activated when the stressful situation subsides in order to maintain physiological homeostasis (Won and Kim, 2016). The parasympathetic response instigates an opposite effect to the SNS, in which decreases in respiration and heart rate are observed, preparing the body for rest (Powley, 2013). In conditions where stressful situations persists for a long time the SNS continuous to be activated leading to increased levels of E and NE creating a maladaptive response affecting the inflammatory immune response (Won and Kim, 2016) and increasing strain on the heart (Schubert et al., 2009).

The release of NE in the amygdala, has been implicated in increasing both working memory and emotional memory function. Increased levels of brain NE has been shown to affect memory consolidation through activation of noradrenergic projections to the Amygdala (Baldi and Bucherelli, 2005). A review of the literature (Chamberlain et al., 2006) indicated that when the action of NE in the brain is blocked emotional and working memory is impaired. While agents that increased uptake of NE enhanced emotional memory capacity (Chamberlain et al., 2006). Therefore, findings indicate that increased action of SNS positively impacts on memory performance, while maladaptive responses can cause damage to health.

A second, slower system activated in response to a stressor is the Hypothalamic Pituitary Adrenal (HPA) axis, key for the neuroendocrine adaption to stress (Lundberg, 2005). Through physical or psychological stressors, the hypothalamus is activated, initiating a cascade of neurobiological events (HPA axis). These events start with the release of the corticotrophin releasing hormone (CRH) into the anterior pituitary, signalling the synthesis and release of the adrenocorticotropic hormone (ACTH) into the peripheral blood system (Gjerstad et al., 2018; de Kloet et al., 1998; de Kloet et al., 1990). ACTH then signals the release of glucocorticoids from the adrenal cortex (Allen et al., 2014a). Glucocorticoids are a class of corticosteroid hormones that produce a wide range of effects in a variety of systems, such as metabolic processes and the immune system (Chrousos, 1995; Cherrington, 1999; Macfarlane et al., 2008). This HPA axis is regulated by a negative feedback mechanism that involves the activation of glucocorticoid receptors, situated in the brain and anterior pituitary (de Kloet et al., 1999). When glucocorticoids levels reach a certain concentration in the blood, a negative feedback loop is triggered in which glucocorticoids bind to mineralocorticoid and glucocorticoid receptors in the anterior pituitary and the hippocampus (Schulkin et al., 1994; McEwen et al., 1986). The hippocampus activates GABAergic (inhibitory) projections in the hypothalamus, inhibiting ACTH release and ceasing the HPA axis reaction to stress (de Kloet et al., 1999). The feedback loop comprises of two streams, long and short feedback. In a long feedback loop (hours-days) negative feedback is created via glucocorticoid receptors situated within the brain-pituitary system (de Kloet et al., 1999). For the short feedback loop (minutes), glucocorticoid receptors situated peripherally in the adrenal cortex are activated, this short feedback loop then suppresses adrenal glucocorticoid release, reducing HPA axis response to stress (Peters et al., 2007).

Glucocorticoids are important for behavioural adaption to stress (de Kloet et al., 1990). Glucocorticoids (in humans, cortisol) prepares the body to cope and respond to stressors through mobilisation of lipids (Jefferies, 1991) and increased cognitive processing (de Kloet, 2000). Studies have shown that after administration of glucocorticoids during stimulus presentation, memory was strengthened for both neutral and arousing information, indicating that moderate stress could improve encoding of information (Akirav et al., 2004; Finsterwald and Alberini, 2014). Consequently, physiological stress response could facilitate memory consolidation enabling the individuals to cope with the same stressor more easily the second time it is encountered (de Kloet et al., 1999).

In summary, the physiological response to stress enables the body to respond effectively to stress within the environment. This response is dependent on the nature of the stressor and the length of time the stressor is perceived. See Fig. 1 for a visual representation of the physiological stress response.

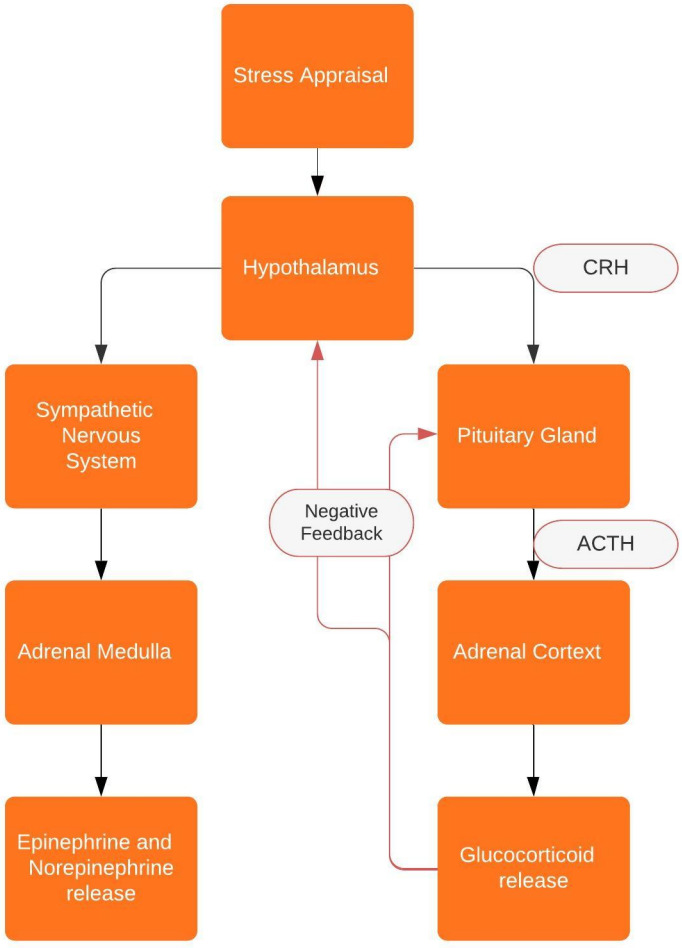

Figure 1 *Diagram of the physiological stress systems.*

2.3.2 The interaction of stress and smoking behaviour

Research on smoking outlined below indicates how both, short-term and long-term smoking behaviours, have differential effects to the physiological stress response and how in turn, stress influences smoking behaviour.

2.3.2.1 Smoking effects on the stress response

Smoking has been found to impact levels of both short- and long-term stress. This impact depends on the amount of nicotine and time spent habitually smoking. The differential effects of smoking on the stress response are described below.

2.3.2.1.1 Acute administration of nicotine

Immediately after nicotine administration (e.g., after acute nicotine intake through smoking), the physiological SNS stress response increases. Smoking cigarettes stimulates the SNS (Middlekauff et al., 2014). For example, it has been shown that nicotine increased activation of HR and blood pressure (Roy et al., 1994; Ginty et al., 2014). After inducing a SNS response, nicotine intake reduces NE uptake, which maintains the effects of NE continuing the SNS stress response (Grassi et al., 1992).

In addition, acute nicotine intake also induces an increase activation of the HPA axis (Kirschbaum et al., 1992; Mendelson et al., 2005; Mendelson et al., 2008). Nicotine binding to nAChrs in the hypothalamus induces the release of CRH stimulating the release of ACTH from the pituitary and subsequently cortisol release from the adrenal glands (Richards et al., 2011). For example, it has been shown that cortisol levels raise significantly after two cigarettes (Kirschbaum et al., 1992; Rohleder and Kirschbaum, 2006). Both SNS and HPA stress systems respond to acute nicotine intake. However, if nicotine intake continues over a prolonged period of time changes in these responses can be observed.

2.3.2.1.2 Habitual nicotine use

While acute dosage of nicotine may temporarily increase the physiological stress systems, habitual use of nicotine may affect the stress system in a more permanent and different manner. Habitual smokers demonstrate different patterns in the SNS stress response, compared to non-smokers, due to the pharmacological effects of nicotine on the ANS (Wiggert et al., 2016). Sustained intake of nicotine and the toxic elements of smoke may result in maladaptive responses of the SAM axis, and therefore an attenuation of the SNS system (McEwen, 2007). Research indicates that habitual smokers have lower blood pressure in comparison to non-smokers (Roy et al., 1994). This effect may be in part due to

down regulation of peripheral adrenergic receptors caused by long-term exposure to elevated levels of catecholamines induced by nicotine (Laustiola et al., 1988). These changes result in a less effective SNS response to stress (Straneva et al., 2000).

Habitual nicotine intake has a similar dampening impact on the l HPA axis stress response. Smoking dysregulates the function of the HPA axis in regular smokers (Baron et al., 1995). This dysregulation takes the form of a diminished HPA axis response (Tsuda et al., 1996; al'Absi et al., 2003; Roy et al., 1994; Gilbert et al., 1997; Rohleder and Kirschbaum, 2006; Koob and Kreek, 2007). Some research indicates that the blunted HPA axis response may be a characteristic of individuals who smoke, rather than a consequence of smoking behaviour (al'Absi et al., 2013). For example, a diminished stress response has been evidenced to predict relapse in abstinent smokers (al'Absi et al., 2005) suggesting that blunted reactivity precedes smoking and other addictions (Lovallo, 2006).

2.3.2.2 Effects of stress on smoking behaviour

The effects of smoking on the physiological stress response systems have been explored in the above section, however, this relationship is bidirectional. Stress exposure and the corresponding physiological stress response impact on smoking behaviour from initiation to cessation and relapse is explored in the following sections.

2.3.2.2.1 Initiation of smoking behaviour

Initiation of smoking behaviour usually occurs before the age of 18 (Action on Smoking and Health, 2018). Individuals throughout adolescence display increased levels of risk taking, impulsivity and reward seeking behaviour (Steinberg, 2010; Willoughby et al., 2013). This pattern of behaviour is thought to be due to neurobiological processes that characterise this development period, increased limbic system activity (responsible for reward processing) and continued slow maturation of the prefrontal cortex (responsible for inhibitory control, emotion regulation and executive functioning) (Casey et al., 2008; Ernst et al., 2006). Need of acceptance within the group of peers, increased impulsivity and lack of inhibitory control underlies adolescent's vulnerability to initiating smoking behaviour (DeBry and Tiffany, 2008).

In addition, adolescence is a time of HPA axis maturation and therefore increased sensitivity and exaggerated stress reactivity (Holliday and Gould, 2016). Adolescents and pre-adolescents that display higher levels of stress and daily hassles are more likely to initiate smoking (Courtois et al., 2007; Lim et al., 2014). This early smoking initiation has been

identified as a maladaptive coping mechanism for stress in their everyday lives (Bindu et al., 2011; Torres and O'Dell, 2016). Both perceived stress (Courtois et al., 2007; Lim et al., 2014) and biological markers of the stress, during a time of HPA axis maturation (Holliday and Gould, 2016) predict smoking status later in life.

2.3.2.2.2 Stress and maintenance of smoking behaviour.

Stress is often self-reported as higher in people who smoke compared to non-smokers (Cohen and Lichtenstein, 1990; Carey et al., 1993). This high level of perceived stress is linked to continuation of smoking behaviour, as evidenced by laboratory-based research showing increased smoking behaviour following stress induction (Rose et al., 1983; Pomerleau and Pomerleau, 1987; Karekla et al., 2017). Outside of laboratory investigations, negative mood and stress has been related to increased smoking over time in adolescents (Wills et al., 2002); while in adults, exposure to stressful life events has also been shown to increase smoking urges and smoking behaviour (Chamik et al., 2017). The relationship between levels of stress and smoking behaviour has been indicated to be influenced by a variety of factors, including emotional states, physiological reactivity, individual differences, nicotine dependence and craving (Karekla et al., 2017).

The neural response to smoking cues has been proposed as a possible mechanisms mediating the relationship between stress and urge to smoke. Following stress induction, it has been shown that in response to the smoking cues, the activation of the attention centres of the brain (medial prefrontal cortex, posterior cingulate cortex, dorsomedial thalamus, medial temporal lobe, caudate nucleus) are increased (Dagher et al., 2009). Importantly, the post stress neural response, predicts subsequent cue reactivity to smoking, suggesting that this could be a mechanism aiding maintenance of smoking behaviour (Dagher et al., 2009). Altered frontal activity due to stress has been suggested to reduce the cognitive control of behaviour, leading to more impulsive reward seeking behaviour (Arnsten, 2009), such as smoking (Li and Sinha, 2008).

Another mechanism which may serve to maintain smoking behaviour, could be the increase of stress experienced with the onset of withdrawal symptoms (Saladin et al., 2012). Nicotine has negative reinforcing properties, as it removes withdrawal symptoms (and therefore, the associated perceived stress) experienced in smoking abstinence (Russell, 1980; McKee et al., 2011). It has consequently been proposed that smoking behaviour is maintained as nicotine acts on the nAChrs in dopamine neurons of the VTA, creating rewarding pleasure feelings after acute nicotine intake, and decreasing feelings of stress (McKee et al., 2011).

Continued smoking behaviour causes higher tolerance to nicotine, by desensitisation of nicotine receptors $\alpha_4\beta_2$* nAChRs (Laviolette and van der Kooy, 2004), preventing dopamine release. In order to obtain the reinforcing effects of smoking and remove feelings of stress, higher nicotine intake is needed (Markou, 2008). Consequently, associations between reduced stress and increased reward from smoking, aids the maintenance of smoking behaviour in states of increased nicotine and dopamine reward pathway tolerance (Benowitz, 2009).

2.3.2.2.3 Stress and smoking cessation

Perceived stress plays a role in the ability of smokers to quit. Smokers who quit successfully typically report lower perceived stress before cessation in comparison to those who did not succeed (Cohen and Lichtenstein, 1990). It has been suggested that stress is one of the most prominent determinants of a successful quit attempt (Skov-Ettrup et al., 2017). Furthermore, expectations of increased levels of stress after quitting can act as a barrier to cessation. For example, it has been reported that individuals are less likely to make a quit attempt if they expect their stress will increase as a direct result (Robles et al., 2016). Additionally, the expectation of increased stress after cessation is higher in individuals who have previously made a quit attempt, compared to those making their first attempt (Skov-Ettrup et al., 2017), as previous unsuccessful quit attempts that were not may be perceived as stressful by the individual (Manning et al., 2005), in turn leading to increased anticipated stress for any subsequent quit attempts. This association could deter individuals from making quitting attempts, maintaining the addiction.

2.3.2.2.4 Stress and smoking relapse

A growing body of evidence has shown that stress increases the risk of relapse in individuals abstinent from nicotine. For example, Cohen and Lichenstien (1990) found that smokers who reported higher levels of stress prior to abstinence, or during the initial period of abstinence, were likely to relapse within a short period after the quit attempts. Similar findings have been reported with a variety of stressor types including increased job strain (Rowe et al., 2015), social stress (Niaura et al., 2002), financial stress (Siahpush and Carlin, 2006) and a variety of psychological stressors (Slopen et al., 2013). As discused previously, stress activates brain regions linked to nicotine withdrawal (Ashare et al., 2016) cueing smoking behaviour and leading to smoking relapse (Wills et al., 2002; Carey et al., 1993; Shiffman et al., 1996; McKee et al., 2011).

The HPA axis mechanism may be related to smoking relapse. Research indicates that when a quit attempt is made, at two weeks post-attempt the levels of cortisol as measured in saliva drop by 40% in comparison to individuals that continued to smoke (Frederick et al., 1998). Further to this, drops in levels of plasma cortisol after cessation has been related to rates of relapse (Hughes et al., 1988). Those who display greater reduction in HPA axis reactivity were evidenced to relapse sooner than those who showed less cortisol reduction as measured in saliva (al'Absi et al., 2004).

The mechanism in which cortisol levels associated with the HPA axis response affects relapse behaviour has been explored. In periods of cessation during a quit attempt, previously desensitized nicotine receptors (nAChRs) are activated again causing withdrawal symptoms (Dani and Heinemann, 1996). Low levels of saliva cortisol evidenced in periods of abstinence (Frederick et al., 1998) may add to the existing withdrawal symptoms by reactivating nAChRs (Robinson et al., 1996; Pauly et al., 1988), increasing the risk of relapse (Cohen and Lichtenstein, 1990). However, the reduction in cortisol levels after cessation has not always been found, e.g., Pickworth et al. (1996) found similar plasma cortisol levels between abstinent and ad libitum smokers, while Ussher et al. (2011) found that salivary cortisol levels remained stable over a short period of abstinence. The differences in findings may be due to the measurement technique of cortisol, as measurements of saliva versus blood samples provide evidence as to the different aspects of the cortisol response (Richards et al., 2011).

2.4 Stress and smoking cessation interventions

There are a large range of smoking interventions that utilise different behaviour change techniques to target aspects of smoking behaviour and addiction (for review see Michie et al. (2011)). Within this section, interventions that utilise techniques to modify the stress levels of smokers, either by reducing or increasing the response have been summarised below.

2.4.1 Smoking cessation intervention reducing stress

Given the links between tobacco addiction and stress systems as outlined above, stress has been identified as a prominent barrier to smoking cessation (Skov-Ettrup et al., 2017; Ashare et al., 2016; Middlekauff et al., 2014). Research has investigated the use of behavioural and pharmacological treatments that target reducing stress in an attempt to increase the chances of smoking cessation.

Behavioural stress management strategies are described in the literature as techniques that can aid smoking cessation. Specific techniques are often not described in detail but have been shown to include relaxation techniques (Tsourtos and O'Dwyer, 2008) as well as cognitive behavioural therapy based practice, which aims to challenge the associations between smoking and stress and provide situational techniques (Yalcin et al., 2014). Mindfulness techniques have also been suggested to benefit smokers due to the possibility of reducing negative affect experienced in withdrawal (Vidrine et al., 2015). Systematic reviews of a range of smoking cessation techniques and interventions including stress management strategies, have been found effective specifically in women (Torchalla et al., 2012) and older populations (Appel and Aldrich, 2003) of smokers. While mindfulness specifically was found to have equivalent effects on abstinence or smoking behaviour reduction, in comparison to alternative behavioural smoking interventions (Maglione et al., 2017).

Pharmacological treatments are also used to reduce stress and promote smoking cessation. Anxiolytic drugs, such as Guanfacine, an α_{2A}-adrenergic agonist bind to receptor sites for E and NE, effectively blocking the agonistic action of the glucocorticoid slowing down the action of the SNS stress response (Bylund, 2006). The evidence does implicate that drugs of this type may be effective in reducing levels of stress and anxiety, but these changes do not relate to smoking cessation or reduction (Beard et al., 2016). Later research however, contradicts these findings indicating the drug Guanfacine trialled versus a placebo was found to reduce acute stress and increase self-control over smoking behaviour during periods of short-term stress (McKee et al., 2015).

There is a large amount of research implicating the role of stress in smoking initiation, maintenance and relapse (e.g., (Siegel et al., 2017; Skov-Ettrup et al., 2017; Bindu et al., 2011; Buchmann et al., 2010; Childs and de Wit, 2010; Siahpush and Carlin, 2006; Ng and Jeffery, 2003; Niaura et al., 2002; Shadel and Mermelstein, 1993). Despite this evidence, research that explores specific techniques aimed at reducing stress for smoking cessation is not prominent. Research that does exist indicates reducing stress could be an effective technique for smoking cessation.

2.4.2 Fear appeals and threat

Although stress reduction has been discussed above as a factor that could promote smoking cessation, fear and fear appeals (that evoke a stress response) have been frequently used in smoking cessation campaigns (Ruiter et al., 2014).

Fear is an emotional state that evokes physiological arousal (Steimer, 2002). Fear appeals are messages that convey the harm a behaviour can have in an attempt to persuade their audiences into changing their behaviour (Dillard et al., 1996; Maddux and Rogers, 1983). Fear appeals depicting health problems caused by continued smoking have been made compulsory to be displayed on cigarette and tobacco packaging since October 2008 in the UK (Action on Smoking and Health, 2018).

Several theoretical frameworks apply to the mechanisms of behaviour change through implementing fear appeal messages. One of the most widely applied is the Protection Motivation Theory (PMT) (Maddux and Rogers, 1983). The PMT suggests that fear appeals prompt threat appraisal (assessment of threat severity and personal susceptibility) and coping appraisal (response efficacy and self-efficacy) which when combined generate intent to change the behaviour of concern (e.g., smoking cessation would be more likely to occur if the individual believes smoking poses a severe threat to their own health, and thinks that s/he would be successful in attempting quitting). The Extended Parallel Process Model (EPPM) (Witte, 1994) extends ideas from the PMT, proposing that threat perception initiated by the fear appeals instigates danger control processes which motivates the individual to take action in reducing risk. If the recommended action (in this case smoking cessation) received from the fear appeal is seen to be effective and feasible, then risk reduction action is instigated. However, some coping appraisal strategies are used by individuals to reduce the fear (e.g., denying the threat, avoidance of the messages, etc.) which may prevent action from being instigated. Therefore, other measures counteracting these coping strategies may be required.

There is some evidence to suggest that fear appeals are effective in changing health behaviours and more specifically smoking behaviour. Meta-analyses evidence indicates that the strength of the fear appeal is related to the magnitude of the behaviour change (Mongeau, 1998; Boster and Mongeau, 1982; Sutton and Hallett, 1988). Similar findings were reported in a more recent meta-analysis study showing that pictorial health warnings regarding smoking behaviour are more effective when they elicit strong emotional reactions

(Hammond, 2011). Furthermore, as supported by the PMT and EPPM models outlined above, fear appeals can be made more effective with the inclusion of self-efficacy statements, and by depicting high severity and personal susceptibility (Tannenbaum et al., 2015). Recent research also suggests that the intensity of an individual's negative emotions, generated by the message can impact on behaviour change, with reports of stronger negative emotions equating to increased quit attempts over less intense negative emotions (Cho et al., 2018).

The research mentioned above suggest that the relationship between the strength of fear and smoking reduction adheres to a linear model of behaviour change (i.e., the stronger the fear is, the more effective it would be in reducing smoking behaviour) (Boster and Mongeau, 1984 as cited in Witte and Allen (2000)). Other authors have proposed a curvilinear model of the relationship between the fear and behaviour change (Dillard et al., 2017). Research has shown that high levels of fear is less effective than moderate levels as they may create defensive and avoidant behaviour and disengagement from the fear appeal message (Tannenbaum et al., 2015; Higbee, 1969; Janis and Feshbach, 1953; Millman, 1968). For example, daily smokers were found to attend less to high-threat information about smoking than low-threat information (Kessels et al., 2010; Kessels et al., 2014). Adding to the mixed findings with regards to the efficacy of fear appeal messages, (Kok et al., 2018) a review criticises research into fear appeals, stating that research needs to include a comparison of threatening and non-threatening information including levels of self-efficacy in participants to determine the role of the fear appeal on smoking behaviour. Indeed, research has shown that the impact of fear appeals may vary based on the message content, such as inclusion of self-efficacy message (Tannenbaum et al., 2015), and the targeted audience (Ferguson and Phau, 2013; Quinn et al., 1992)**.** For example, the use of general health statements or factual health statements regarding smoking behaviour has been found effective in a general population, but elicits higher fear in i) females versus males (Quinn et al., 1992), ii) adolescents vs young adults (Ferguson and Phau, 2013), iii) western vs eastern cultures (Miller et al., 2007).

Furthermore, repetitive exposure to fear appeals may be less effective in promoting behavioural change, as the individuals could be desensitised to the message content (Khandaker and Rana, 2016). For example, it has been shown that repeated exposure to the fear appeal messages, specifically graphic health images, can lead to reduced impact of the message on behaviour change (Ratneswaran et al., 2016) which is not often tested in

experimental evidence. Additionally, cognitive dissonance, the state of having inconsistent thoughts related to a specific behaviour (McMaster and Lee, 1991), may play a role, as smokers could deny the problem of smoking upon health to minimise the threat to the self (Maynard et al., 2013; Munafo et al., 2011).

In order to understand the neurobiological processes, mediating the effects of fear appeal messages on smoking behaviour, research has included measures of physiological and neural activity. Overall, neural research findings on smoking behaviour related fear appeals suggests that messages eliciting high levels of fear do not induce avoidance behaviour towards to messages content (Wang et al., 2015; Riddle et al., 2016). Functional Magnetic Resonance Imaging (fMRI) has been used to examine the neural activity of smokers while viewing the graphic smoking images rated as either high or low in 'emotional reaction' value (Wang et al., 2015; Phan et al., 2002; Ressler, 2010). Results indicate that in comparison with images rated low in emotional reaction, images rated high by the participants i) increased neural activity in several brain areas (amygdala, hippocampi, inferior frontal gyrus and insula), ii) were recalled more easily and, iii) evoked less urge to smoke (Wang et al., 2015). Importantly, the amygdala is a key brain area responsible for identifying and responding to threats (Phan et al., 2002; Ressler, 2010), and facilitates encoding of emotional memories (Maren and Quirk, 2004). It has been shown that increased neural activity in the amygdala while viewing pictorial smoking images predicts reduction of smoking behaviour (Riddle et al., 2016). Therefore, the neural research explored above indicates that images that elicit high levels of health threat are related to reductions in smoking behaviour. Additionally, higher fear and threat inducing messages, as measured by self-report of negative feelings and electrodermal activity (physiological measure of SNS response) have also been linked to a stronger desire to stop smoking and find information to quit smoking (Droulers et al., 2017).

In conclusion, while research into psychological, neural and physiological effects of fear appeal messages, indicate a positive influence on behaviour change of smoking behaviour, several factors such as population characteristics or previous exposure to the messages, among others, could affect the efficacy of the message. Further research is still needed to investigate mediating mechanisms and moderating factors involved in the effect of fear appeal messages on behaviour change.

2.5 Women and smoking cessation

Reduction or cessation of smoking behaviour may be more difficult to attain for women, as women report increased positive mood after smoking in comparison to men (Perkins et al., 2006) and are more sensitive to the rewarding effects of smoking (Perkins, 2009). Differences in smoking behaviour, and more relevant for this thesis in cessation outcomes, may be in part exacerbated by stress and sex differences. Outlined below are some of the differences in stress and smoking behaviour due to sex specific barriers women experience in smoking cessation.

2.5.1 Sex differences, effects on smoking and stress systems

Sex differences in terms of the impact of smoking on the stress response and the effects of stress on smoking, is relatively understudied in the research. In terms of the effects of smoking on the SNS stress response, measures of systolic blood pressure indicate that men who smoke show a greater increase in blood pressure from rest to during stress as compared to women who smoke (Kotlyar et al., 2017; Hering et al., 2008). Authors relate the low levels of SNS stress response in women to subsequent cessation relapse rates (Lemieux and al'Absi, 2016), indicating the influence of smoking on SNS stress reactivity could negatively impact women's ability to stop smoking.

The influence of smoking on HPA axis reactivity also observes sex differences. Women who smoke were found to display a greater blunting of cortisol in response to a stressor as compared to women non-smokers, yet the smoking status of male participants had no significant effect on levels of cortisol (Back et al., 2008). Attenuated HPA axis responses to stress, as evidenced through levels of cortisol have been associated with increased rates of relapse (al'Absi et al., 2017). Additionally, women but not men with the greatest drop in cortisol levels on the first day of abstinence, experienced more severe affective withdrawal symptoms (al'Absi et al., 2004). Therefore, as women have been found to have more attenuation of cortisol levels compared to male smokers, this may contribute to the reports of women having less success than men in unassisted smoking cessation attempts (Smith et al., 2015).

Sex differences can also be observed in the influence of stress on smoking behaviour. Research indicates that women respond with more craving to smoking cues than men (Field and Duka, 2004; Tong et al., 2007; Knott et al., 2008). Furthermore, research indicates that compared to men, women who smoke displayed greater levels of craving, stress and negative

affect after being presented with stressful cues in the lab (Saladin et al., 2012), and in the natural environment of the smoker (Tomko et al., 2018).

The above evidence indicates that physiological changes due to smoking may adversely impact women more than men. Additionally, research on the influence of stress on smoking behaviour suggest that women who smoke have higher levels of cue induced craving to both smoking and stress cues, allowing for maintenance of smoking to occur. In spite of the growing body of evidence on sex-differences on stress systems and smoking behaviour, tobacco control policy and practice has mostly remained sex blind, with little recognition or understanding of the greater challenges women face compared to men in smoking behaviour and cessation (Amos et al., 2012). However, both instances of sex differences in relation to stress and smoking behaviour, indicate increased barriers to smoking cessation for women as compared to men. This highlights the need for sex specific smoking cessation approaches, especially, when considering the influence of stress.

2.5.1.1 Women's Sex hormones influence on smoking behaviour

Similar to the bidirectional impact of the stress systems and nicotine described above, sexual hormones can affect and be affected by nicotine intake.

During the menstrual cycle the hormones oestrogen and progesterone fluctuate (Reed and Carr, 2000). At the start of the menstrual cycle, just after menstruation, oestrogen and progesterone levels are low. Oestrogen then slowly increases during the first half of the cycle, named the follicular phase, and peaks around the 14th day of the cycle (ovulation). Oestrogen then starts to decrease through the second half of the cycle, named the luteal phase. At the same time, progesterone rises slightly towards the end of the follicular phase and peaks mid luteal phase. After the mid luteal phase both the oestrogen and progesterone decrease rapidly before menstruation (Jenkins, 2011).

Smoking cigarettes has been shown to modulate levels of sex hormones. In comparison to non-smoker counterparts, premenopausal women who smoked had higher levels of progesterone (Duskova et al., 2012) and testosterone (Duskova et al., 2012; Cupisti et al., 2010) and less variation in oestrogen across all phases of the menstrual cycle (Gu et al., 2013). These changes in sex hormones during the menstrual cycle may not be permanent, as they could return to levels observed in non-smokers after smoking cessation (Allen et al., 2014b).

As well as the influence of smoking on sex hormones, a range of research has showed that the hormonal fluctuations during the different phases of the menstrual cycle in women impact upon smoking behaviour. For example, high levels of oestrogen have been suggested to increase dopamine release in the striatum which subsequently impacts on dopamine release in response to nicotine intake, affecting smoking's rewarding properties (Lynch et al., 2002). A review (Carpenter et al., 2006) and meta-analysis (Weinberger et al., 2015) report that in comparison to other menstrual phases, the luteal phase showed i) greater withdrawal symptoms, ii) greater cravings (though only a tendency towards significance was reported), and iii) greater reported negative subjective effects of nicotine, both during the luteal phase, and when progesterone is administered. However contradictory evidence indicates that increased levels of progesterone (which peaks within the luteal phase) is associated with an increase in the odds of being abstinent (Schiller et al., 2012). Differences in these findings may be due to variations in the measurement of menstrual hormones, (Allen et al., 2016).

An additional complexity in research in relation to sex hormones and smoking behaviour is modification of naturally occurring hormones through the use of oral contraception. Women of reproductive age may regularly take oral contraceptives (OC) which influence the levels of hormones within a women's cycle (Cea-Soriano et al., 2014). Users of OC also have a higher cardiovascular response to stress (Davis, 1999; Masson and Gilbert, 1999; Emmons and Weidner, 1988; West et al., 2001; Harrison et al., 2015; Davis and Matthews, 1990) which, as discussed in a previous section, may impact on smoking behaviour. Secondary data analysis (Allen et al., 2018) found that OC users had significantly more adverse withdrawal, negative affect during withdrawal and increased craving of nicotine compared to non OC users, yet were more likely to be abstinent by the end of treatment.

Research suggests that smoking behaviour may also be closely linked to the premenstrual syndrome (PMS) in women (Allen et al., 2009). PMS is characterised by emotional and physical symptoms which can include but are not limited to depression, irritability, bloating and breast tenderness (Allen et al., 1996). These symptoms are likely to occur during the luteal phase of the cycle (Johnson, 1987). Withdrawal symptoms, craving, smoking behaviour and levels of depression were found to increase in women who smoked during the luteal phase of the cycle alongside levels of PMS (Sakai and Ohashi, 2013). In addition, Pang et al. (2017) indicate that PMS is associated with an increased usage of cessation aids

during quit attempts, signifying a higher craving for nicotine for women smokers that experience PMS. This craving response may be related to stress induced smoking (Buchmann et al., 2010), as pain can increase the release of cortisol (Tennant, 2013)

A number of limitations in the research discussed above should be considered: i) the use of small sample sizes; which may be restricting researchers from investigating subphases (Weinberger et al., 2015), ii) difference in the inclusion and exclusion criteria, and, iii) the use of different methodology to confirm the different phases and use of contraceptives (Franklin and Allen, 2009). Despite these caveats, the evidence supports that levels of sexual hormones at different times of the menstrual cycle and life span impact women's smoking behaviour.

Differences as the reproductive stage, menstrual cycle and use of oral contraceptives is not often reported in smoking research and can potentially impact on both smoking behaviour and stress response in women (Pang et al., 2017). The above research therefore demonstrates how caution should be used in interpreting results from studies that focus smoking cessation and smoking interventions as they could impact women differentially as compared to men.

2.5.2 Women, smoking and appearance

Physical appearance is highly valued in society (Frevert and Walker, 2014). Post-feminist perspectives on beauty normalise pressure to attain perfection in appearance and health (Riley et al., 2018). Western ideals for women's beauty glorify thinness, flat stomachs, thin waists, long legs and flawless skin (Groesz et al., 2002). Aspects of appearance hold value in our society and the effort to maintain them influence smoking behaviour in women. The influences of appearance on smoking behaviour is discussed below.

2.5.2.1 Weight gain concern

Weight gain concern is a prevalent barrier to smoking cessation in women (Pomerleau et al., 2001; Levine et al., 2013; Rosenthal et al., 2013). Mass media reflects cultural value statements perpetuating that shape and weight determine identity (Polivy and Herman, 2007) e.g. suggesting 'fat' is ugly and 'thinness' is socially desirable (Levine, 2012).

Research suggests that women who are successful in their quit attempts gain on average three kilograms of weight (Tan et al., 2018) and gain more weight than women who continue to smoke (Levine et al., 2013). This knowledge regarding the increase in weight following cessation has contributed to post-cessation weight gain concern (WGC); the concern over

gaining weight after quitting smoking (Pomerleau et al., 2001; Germeroth and Levine, 2018). WGC has been indicated as highly prevalent in women, specifically in women who accessed a smoking quit line services within the USA (Bush et al., 2009). Consequently, WGC can act as a barrier to cessation and is related to initiation and relapse in smoking behaviour (French and Jeffery, 1995; Germeroth and Levine, 2018) as well as intentions to resume smoking if weight is gained (Dobmeyer et al., 2005). Women who were previously unsuccessful in a quit attempt, but the attempts resulted in weight gain stated greater concern over repeated weight gain if they were to attempt to quit smoking again (Veldheer et al., 2014).

As well as deterring women from quitting smoking, WGC also can motivate some women to continue smoking as a method of weight control (Fulkerson and French, 2003). Women who gained weight in previous cessation attempts, were more likely to subsequently use smoking to control their weight (Weekley et al., 1992), resulting in maintenance of smoking over time. Adherence to smoking cessation programmes has also been influenced by WGC, as women who were concerned about gaining weight as a result of quitting, were more likely to drop out of smoking cessation programmes before completion (Mizes et al., 1998).

Although research suggests that WGC has a major contribution to the continuation of smoking behaviour in women, the size of its impact may be overstated, as other individual differences, such as depression and stress may have a stronger influence on smoking outcomes (Ludman et al., 2002). Evaluating literature on the influence of WGC on smoking outcomes can be complicated, as research includes a variety of study designs, participant demographics and measurement tools (Veldheer et al., 2014). Non-validated measurement tools could be considered the greatest problem (Germeroth and Levine, 2018). Many measures of post-cessation WGC use only one item, which is likely to limit the reliability and internal consistency of the measure (Borrelli and Mermelstein, 1998). Use of different study design (with the inclusion of a variety of variables as covariates or moderators) also can interfere in effective evaluation and combination of results, making the findings unclear regarding the effect of WGC on smoking behaviour (Germeroth and Levine, 2018). Therefore, although the influence of WGC is undeniable, it remains unclear to what extent WGC influences smoking behaviour in women.

2.5.2.2 Facial ageing.

Going beyond WGC, women who smoke also report concerns over the general satisfaction with appearance (appearance evaluation) more so than women who do not smoke (Grogan, 2012a). A common appearance concern is the concern over ageing or wrinkling (Grogan, 2017). It is assumed in society that women age more quickly than men (Clarke and Korotchenko, 2011). While societal pressure dictates that women should aim to maintain a youthful appearance (Cepanec and Payne, 2000). Thus, anti-ageing activities are engaged with related to beauty and appearance concerns (Calasanti et al., 2016).

Part of the natural ageing process is facial wrinkling. Wrinkles occur on the face due to a range of factors including biological and genetic factors, alongside external factors such as ultraviolet exposure and cigarette smoke (Clarke and Korotchenko, 2011). Clarke (2012) indicates that wrinkles are signifiers of ageing that contain negative connotations, such as the decline in physical attractiveness and the lessening of sexual desirability. The expectation of a youthful appearance has fuelled the cosmetic surgery industry, as evidenced by increases in cosmetic procedures in the 21st century (Grogan, 2017).

Smoking has a detrimental effect to facial ageing (Knuutinen et al., 2002; Koh et al., 2002). The effect of smoking accelerating facial ageing has not gone unnoticed by tobacco consumers, e.g., research has showed that lifetime smokers have increased odds of reporting they look older than they are (Millard et al., 2019). As anti-ageing activities are actively engaged in to improve appearance, (Calasanti et al., 2016) the anti-ageing benefits of smoking cessation may serve as motivation to reduce or stop their smoking behaviour (Grogan, 2016).

2.6 Chapter Summary.

This chapter has outlined the prevalence and impact of smoking behaviour, with emphasis on how women encounter increased and more specific risks than men. Thus, providing rationale as to the sample choice of women within this thesis.

The stress response and its interaction in smokers and smoking behaviours was then outlined, explaining the complex nature stress plays in smoking behaviour. It is argued that although short and long-term stress is implicated in the initiation, maintenance and relapse of smoking, short-term stress when increased acutely and not prolonged may also contribute to smoking cessation. Greater attention needs to be payed to the stress induced by smoking interventions, this thesis aims to address this in conjunction with appearance based

intervention delivery. Lastly, the topics of women, smoking and appearance were discussed. Literature helps to understand how appearance can both be a facilitate and become a barrier to smoking cessation.

Chapter 3 within this thesis, will go on to discuss how appearance aspects have been incorporated into smoking interventions. An updated systematic review of evidence of appearance based interventions for smoking cessation is provided, following on from the previously published review (Flett et al., 2013).

3 Chapter 3: Physical appearance and smoking. A review of the literature and systematic review of appearance based smoking interventions.

3.1 Chapter introduction

In the previous chapter (Chapter 2) literature related to smoking, stress and specific barriers to smoking cessation in women were discussed, alongside links between appearance and smoking behaviour. The current thesis employs a specific intervention that utilises appearance to aid smoking cessation. Therefore, to further understand appearance based interventions for smoking, the current chapter presents background information on appearance as a basis for intervention. Additionally, an updated systematic review is provided, that aimed to assess articles published in recent years regarding appearance based interventions for smoking cessation. The chapter updates a systematic review published in 2013 (Flett et al., 2013), articles retrieved were summarised narratively with a quality assessment of the articles found. Limitations were identified in the current research with recommendations made for improvement considered in later research within this thesis. Lastly, a summary of the research published after the review was conducted is included to close the gap in understanding of appearance based interventions for smoking cessation.

3.1.1 Appearance related smoking interventions.

As discussed in the above chapter (Chapter 2), both WGC and facial wrinkling impact on smoking behaviour. These appearance aspects and others have been utilised within smoking interventions in order to aid smoking cessation. A previous systematic review investigating the efficacy of appearance based interventions for smoking cessation (Flett et al., 2013), identified three appearance-related categories of smokers' concerns: facial wrinkling, weight gain and dental aesthetics.

Interventions have been developed in order to reduce WGC with the aim of reducing the barrier it causes to smoking cessation. Some programmes include behavioural WGC reduction techniques that include counselling to help participants to maintain a positive attitude regarding their weight, situated in or alongside other stop smoking techniques (Pirie et al., 1992; Copeland et al., 2006). These techniques have demonstrated mixed findings regarding smoking outcomes (Flett et al., 2013). Alternatively, other interventions have given specific post-cessation WGC reduction training centred on cognitive behavioural therapy elements to directly reduce the amount of WGC (Perkins et al., 2001), evidencing positive results in group cessation rates. Despite the positive results, interventions of both these types were rated as weak by a previous systematic review (Flett et al., 2013) and have

limitations, such as the inclusion of weight monitoring. Similar conclusions were reported in a more recent review of research published between 2011 and 2016, evaluating the relationship between WGC and smoking cessation (intervention components were not assessed) (Germeroth and Levine, 2018).

Ageing and wrinkles are also viewed negatively (Clarke and Korotchenko, 2011), and as mentioned in previous chapters (Chapter 2) the chemicals in tobacco smoke are toxic to the skin creating an increased risk of facial wrinkling (Knuutinen et al., 2002). Many smokers remain unaware of the risks of smoking on the skin, but when asked, smokers believe that this information could influence their decision to quit (Demierre et al., 1999). Focus group discussions conducted by Grogan et al. (2009) indicated that women raised concern about the ageing effects of smoking on the skin and expressed that their intention to quit would increase if the negative effect became evident on their own face. Evidence therefore implies that concern over ageing could be an effective tool for behaviour change. Age-progression interventions, or interventions that emphasise the accelerated ageing or damaging effects on the skin, have been developed on this basis. The intervention has previously been used to influence of a range of unhealthy behaviours including smoking (for previous review see Flett et al. (2013), unprotected sun exposure (Persson et al., 2018b) and drinking (Owen et al., 2019).

Focusing on the use of facial wrinkling interventions, Flett et al. (2013) retrieved seven papers that investigated an appearance intervention related to changing smoking attitudes, intentions or behaviour. All but one of the papers were rated as weak in quality. Within these seven, six investigated the implementation of an age-progression facial wrinkling intervention software. Interventions of this kind show an increase in quit smoking intentions and attitudes (Hysert et al., 2003), and a decrease in smoking behaviour (Hysert et al., 2008) in male and female smokers. Also indicated was an increase in motivation or intention to quit and a reduction in nicotine dependence in female smokers (Weiss et al., 2010; Grogan et al., 2011).

Research within the review that investigated age-progression interventions (Flett et al., 2013) were not conclusive in their reports of the effectiveness of the intervention. Reasons for this may lie in the lack of methodological rigour, as a proportion of the research lacked the inclusion of control group conditions (Hysert et al., 2008; Hysert et al., 2003; Weiss et al.,

2010). All research used a variety of measurement tools and research designs preventing the preparation of meta-analysis in the previous review (Flett et al., 2013).

Lastly smoking has been evidenced to cause negative effects on dental aesthetics including tooth loss, decay (Locker, 1992) and staining (Watts and Addy, 2001). Smokers are more likely to perceive their teeth as discoloured and reported more dissatisfaction with tooth appearance compared to non-smokers (Alkhatib et al., 2005). The 2013 (Flett et al.) review found only one intervention focusing on the effects of smoking on dental aesthetics, results indicate it was not effective in changing smoking in the adolescent participants.

The appearance based interventions discussed above show promise in changing smoking behaviour and intentions. However, research needs to incorporate stricter controls and improve in quality before assumptions can be made on the effectiveness of smoking interventions or preventions of this type.

3.1.2 The Current systematic review

Appearance based interventions discussed above have been identified by the previous review (Flett et al., 2013), searching the literature of published work from 1980-2012. Eleven articles were retrieved that met the search criteria, yet those retrieved were rated as mostly weak in quality. Given the time since the last review (6 years at time of review completion) and fast growth of technology relating to appearance (Rajanala et al., 2018), the systematic review aimed to assess articles published that investigate appearance based interventions for smoking cessation. The present review protocol is based on the previously published review, in order to update our existing understanding of literature and to inform later research practice within the thesis. The aim was achieved through performing the systematic review search, assessing articles that investigated appearance based interventions for smoking cessation, published between 2012 and the date of review commencement.

3.2 Method

3.2.1 Description of searches

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were adhered to for the systematic review search (Moher et al., 2009) (PRISMA checklist, Appendix 1). The search strategy for this systematic review was developed and published on PROSPERO registration (Record: CRD42018086819). The search was conducted between 17th and 22nd May 2018. Electronic literature searches were carried out

using the abstract, title and keywords fields, or those of these fields available in the following online data bases: PsycARTICLES, CIHAHL, Web of Science, Ingenta Connect, PsycINFO, ScienceDirect, Scopus, Wiley online library, Sage Journals, PubMed EU, PubMed US.

3.2.2 Search strategies

Search terms (key words) related to each area were selected based on the 2013 review and developed upon (Flett et al., 2013). Items from the previous review that did not retrieve relevant papers were removed restructured or clarified. For example, in the appearance related terms words relating to appearance, teeth and weight were collapsed in to one search line concerning appearance.

The final search string used was ((appearance) OR (skin) OR (dermis) OR (dermatologist) OR (face) OR (facial) OR (wrinkl*) OR (teeth) OR (dental) OR (dentist) OR (weight)) AND ((smok*) OR (cigarette*) OR (nicotine) OR (tobacco)) AND ((intervention) OR (cessation) OR (program) OR (quit*) OR (software) OR (technology) OR (app) OR (application) OR (photoag*)) AND NOT Publication Type (review). When possible MeSH major topic "smoking cessation" was used to narrow the search. Using the advanced search tool, articles were requested from 2012/01/01 to 2018/05/22.

3.2.3 Inclusion and exclusion criteria

Papers were included in the current review if: (a) they were published between 01/01/2012 and 22/05/2018, (b) investigated an appearance based intervention, [multi-component interventions were accepted e.g., the appearance intervention was a component of an intervention/programme], (c) the intervention was aimed at changing smoking behaviours, attitudes or perceptions, and (d) if quantitative, the study design included i) a baseline measure of smoking outcomes and ii) a comparison post-intervention measure immediately after the intervention and/or at a follow up point.

Studies were excluded if: (a) the whole or any component of the intervention was not focused on appearance; (b) (for quantitative articles) smoking outcomes were not assessed related to the intervention; (c) articles focused on reducing actual weight rather than addressing weight concerns related to smoking cessation; (d) the article was not published in English; or (e) the research studied non-human animals. Furthermore, studies that included only clinical subgroups e.g., participants with depression or schizophrenia, were excluded due to confounding factors that could have affected the intervention outcomes (e.g., use of and type

of medication, adaptations in the intervention to deal with specific aspects of the clinical sample among others).

3.2.4 Paper selection process

The researcher reviewed titles and articles retrieved during the online search. If titles appeared to meet the inclusion criteria, citations were sent to an online reference manager to be stored for abstract review; if the title was not clear a pre-screen of the abstract was performed. Duplicates were removed and abstracts reviewed against the inclusion and exclusion criteria by the researcher and advisor. Full texts were obtained for the final selected articles. Study details were obtained, and quality assessment conducted by the researcher and a member of the supervisory team on all papers marked for inclusion. Disagreement in regard to inclusion of a study was resolved through discussion by the researcher and the supervisory team member. Studies identified for inclusion were reviewed for quality in terms of sample, methodology, reliability, validity, analysis and main findings. Supervisors checked quality ratings and coding of the papers.

3.2.5 Assessment of methodological quality

Quality assessment was performed on the papers using the same tools as the 2013 review (Flett et al., 2013), to assess the progression of research post 2012. The McMasters quality assessment for quantitative papers (Thomas et al., 2004) was used to assess the five quantitative research articles. The assessment tool included six quality ratings: selection bias, design, confounders, blinding, data collection methods and withdrawals/dropouts. Studies can be rated either weak, moderate or strong on these categories in accordance with the standardised guide. One qualitative paper was assessed using the (Walsh and Downe, 2006) quality assessment tool. Areas assessed included: scope and purpose, design, sampling strategy, analysis, interpretation, reflexivity, ethical dimensions and relevance/transferability.

3.3 Results

The combined search revealed 11,885 papers in which titles were assessed in relation to the topic to reduce the total to 108 papers. Duplicates were then removed leaving 66 papers for abstract review. Out of those 66 papers, six (five quantitative and one qualitative) met the inclusion criteria. For a flow chart illustrating the stages of article retrieval, see Fig 2. Six research articles were identified that met the inclusion criteria. Papers focused on facial wrinkling (n = 4) and weight concern reduction (n = 2). Findings from the research are

discussed below and key aspects are summarised in Table 1, quality of the research is assessed, see Tables 2 and 3.

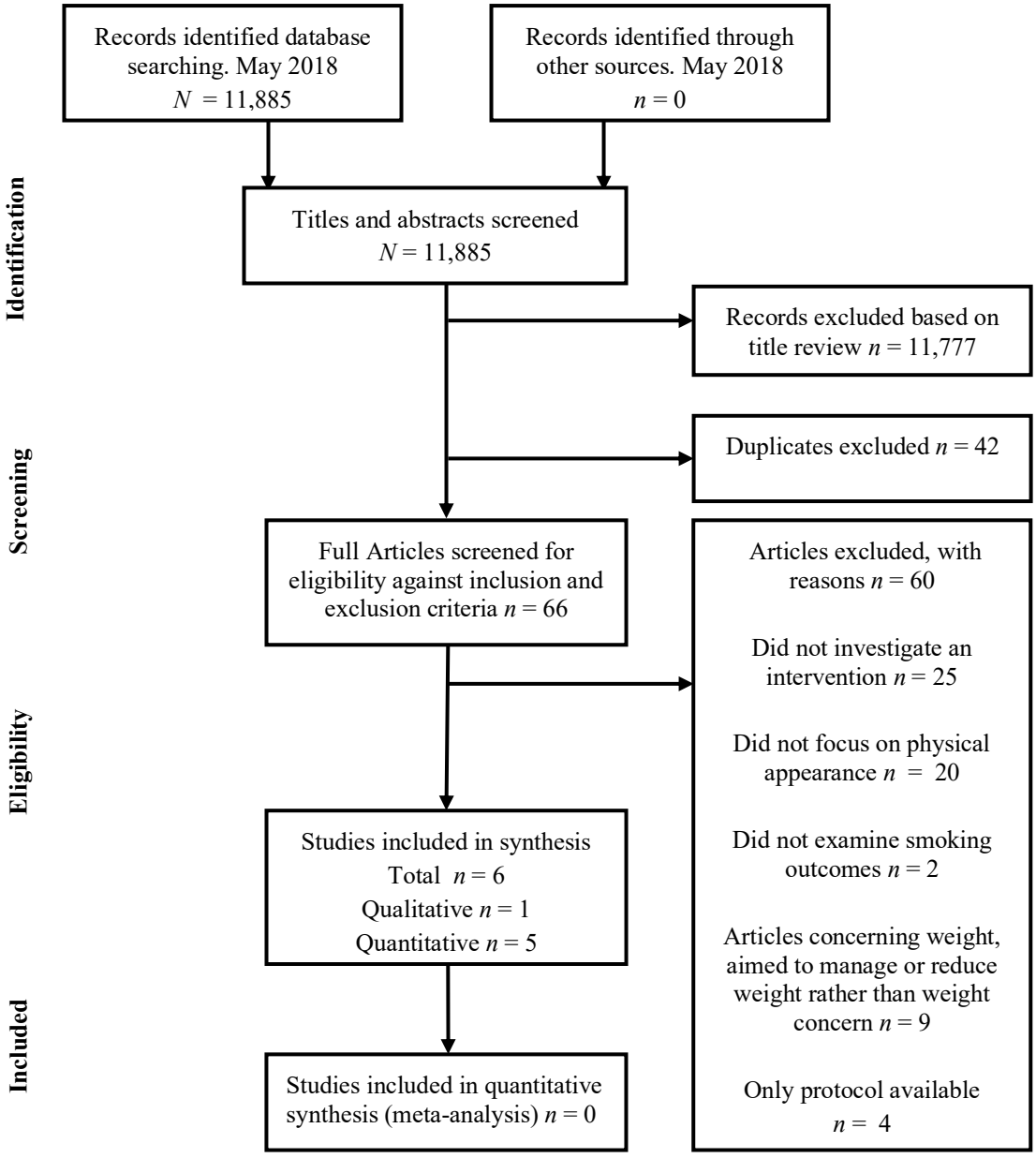

Figure 2 *PRISMA flow chart of the systematic review*

Table 1 *Brief study checklist of studies retrieved for the systematic review.*

Intervention type	Study	Design	N	Participants	Intervention Components and groups	Outcome measures	Results
Weight concern reduction	Bloom et al., (2016)	Cohort analytic	11	Female smokers	1.Distress tolerance intervention (weight concern reduction). 2.CBT smoking intervention. 3.Transdermal nicotine patch.	Smoking abstinence, Weight concern.	Carbon monoxide verified reduction in smoking behaviour at 1 (64%) 3 (36%) and 6 (27%) month follow up, however no statistical information. Reduction in weight concern after the intervention that steadily increased.
Weight concern reduction	Bush et al., (2012)	Randomised controlled trail	2000	Male and Female smokers motivated to quit smoking. Control *n* = 1000 (gender not reported) Intervention *n* = 1000 (gender not reported)	1.Intervention: CBT weight concern program. 2.Control: Standard smoking cessation Quit line.	Smoking behaviour and weight concern	No significant differences in 30-day abstinence prevalence in responders in the standard quit line (33.3%) vs weight concern program (36.8%), $p = 0.240$. Significant reduction of weight gain concern in weight concern program condition ($p < .001$).
Facial Wrinkling intervention	Burford et al., (2013)	Randomised controlled trial	160	Male and Female smokers. Control *n* =80 (Male = 35, Female = 45). Intervention *n* =80 (Male = 25, Female = 55).	1. Intervention: APRIL age-progression. 2.Control: Pharmacist smoking cessation advice.	Smoking behaviour and dependence. Biochemically verified.	Significantly more participants reported not smoking at 6 months follow up in the intervention group compared to control (1.3% control vs 13.8% intervention $p = .003$).

Facial Wrinkling Intervention	Burford et al., (2017)	Controlled trail	98	Male and Female young smokers Control *n* = 48 (gender not reported). Intervention *n* = 50 (gender not reported)	1.Intervention: APRIL age-progression. 2.Control: Standard smoking cessation advice.	Smoking behaviour and dependence.	No significant differences between intervention and control groups, *n* = 14/48 (29.2%) for the control group vs *n* = 19/50 (38%) for the intervention group made a quit attempt (*p* = .35).
Facial Wrinkling Intervention	Flett et al., (2017)	Qualitative Study	30	Male Smokers Interviews (*n* = 21) Focus groups (*n* = 9)	1.Intervention: APRIL age progression.	Intervention, effectiveness and experience	Reports of intentions to quit smoking by majority of participants (*n* = 22).
Facial Wrinkling Intervention	Song et al., (2013)	2x2 Between subject design	62	Male (*n* = 38) and Female (*n* = 24) Smokers	1.Anti-smoking educational game; future face vs no future face. 2.Anti-smoking educational game; self-avatar vs other avatar.	Smoking attitudes and intentions to quit	Significantly stronger negative attitudes towards social smoking in the future face condition compared to the no-future condition (*M* = 7.94 future face vs *M* = 6.81 no-future, *p* <.010). Participants in the future face condition also had significantly stronger intentions to quit compared to the no-future (*M* = 8.37 vs *M* = 7.24, *p*<.05).

Note: The table provides a summary of the key characteristics and findings of the studies identified for review, M = mean.

Table 2 *Quantitative quality assessment of systematic review retieved papers.*

Authors	Selection Bias	Design	Confounders	Blinding	Data Collection methods	Withdrawals and dropouts	Global rating
Bloom et al, (2016)	Moderate (2)	Moderate (2)	Weak (3)	Weak (3)	Moderate (2)	Moderate (2)	Weak (3)
Burford et al, (2013)	Moderate (2)	Strong (1)	Moderate (2)	Moderate (2)	Strong (1)	Moderate (2)	Moderate (2)
Burford et al, (2017)	Weak (3)	Moderate (2)	Weak (3)	Moderate (2)	Moderate (2)	Moderate (2)	Weak (3)
Bush et al, (2012)	Moderate (2)	Strong (1)	Moderate (2)	Moderate (2)	Moderate (2)	Weak (3)	Moderate (2)
Song et al, (2013)	Moderate (2)	Moderate (2)	Weak (3)	Moderate (2)	Moderate (2)	Strong (1)	Moderate (2)

Note: Table provides an overview of the outcomes of the McMasters quality assessment (Thomas et al., 2004). for the quantitative papers selected for review.

Table 3 *Qualitative quality assessment of systematic review retieved papers.*

Authors	Scope and Purpose	Design	Sampling strategy	Analysis	Interpretation	Reflexivity	Ethical dimensions	Relevance/ transferability
Flett et al, (2017)	Clear rationale provided.	Method and design explained in detail, consistent with research intent.	Description provided of sampling method, restricted to geographical location.	Described in detail.	Detail interpretation with sufficient discussion of research process.	Discussion of relationship and influence of researcher to participant.	Ethical procedures explained, with description of documentation used.	Discussion of future directions of research based on previous research and current findings.

Note: Table provides an overview of the outcomes of the Walsh and Downe (2006) quality assessment tool, for qualitative papers selected for review

3.3.1 Facial wrinkling

Four papers (one qualitative study and three quantitative studies) aimed to reduce smoking by simulating the effects of smoking on the face over time.

Flett et al. (2017) conducted a qualitative investigation of male participants experiences of engaging with an age-progression software intervention (APRIL®). The software provides participants with a 3D stream of images of their own face, showing progressive ageing effects of smoking alongside natural ageing progression. An algorithm is used based on normative data from 2000 individuals of a variety of ages, ethnicities, lifestyle habits and published data on the effects of smoking on skin (APRIL Inc, 2018). Male participants also reported whether they felt the intervention was effective in post-intervention interview or focus group sessions (Individual interviews $N = 21$, Focus groups $N = 9$). Inductive thematic analysis uncovered a core theme of 'personal relevance' that was central and linked to all other themes uncovered 'concern over ageing', 'appearance attitudes' and 'intentions to quit smoking'. After taking part in the intervention the majority of participants ($n = 22$) reported positive intentions to quit linked to concern over facial wrinkling. This study provides detailed and in-depth information of the experiences of male participants engaging with this intervention. Findings suggest that male participants concern over the effects of smoking on their appearance may have a positive effect on facilitating quit intentions. Given the qualitative approach the efficacy of the intervention was not assessed. In terms of research quality, qualitative quality assessment indicated that the research was strong in all areas of assessment, leading to the assumption results although interpreted by the researcher can be trusted in terms of a rigorous research design.

Burford et al. (2013) implemented the same age-progression software (APRIL®) in an RCT among smokers within a community pharmacy setting in Australia. Participants in the intervention group ($n = 80$, 31.25% male) received the software accompanied by pharmacist standard stop smoking advice, intervention images were made available for the participant to take home. Participants in the control condition ($n = 80$, 44% male) received only the pharmacist advice. Males and females aged 18-30 were included if they smoked one or more cigarettes a day, had no features on their face that prevented showing the effects of smoking on the skin (e.g., beards), and presented no body dysmorphia. Efficacy of the intervention was measured by the number of cigarettes smoked in the past 30 days and level of nicotine dependence, as measured by the Fagerström test of nicotine dependence (Heatherton et al., 1991). Additionally, a carbon monoxide (CO) breath measure was used to confirm self-

reported smoking abstinence. The study found a significant difference in the proportion of participants that reported quitting smoking and nicotine dependence by 6 months follow up, between the control and intervention group. Out of the 80 participants 1 in the control group reported quitting, compared to 11 out of 80 in the intervention group. The research selected participants from pharmacies in a range of socioeconomic areas and achieving a fully powered RCT. Overall the research shows that participants found the intervention effective. Quality assessment indicated a global rating of moderate quality, with areas such as research design and data collection methods rated as strong. Whereas other aspects such as selection bias and blinding were indicated to be moderate preventing an overall strong rating.

Burford et al. (2017) also used the same age-progression software (APRIL®) outlined above on a sample of French, University of Paris students (n = 98, 50% male). Participants were recruited to a pilot study to test the intervention, on a population of young adults with high levels of smoking. Students in the intervention condition (n = 50) received standard smoking cessation advice, engaged in the age-progression intervention and were asked to report their feelings about the intervention (results not reported). Participants in the control condition (n = 48) received only the standard stop smoking advice. In contrast to the Australian study, participants did not receive a photocopy of the intervention images produced to take home. Exclusion criteria for participants were not described in this paper. Efficacy of the intervention was measured using the Fagerström test of nicotine dependence (Heatherton et al., 1991) and self-report smoking abstinence measured at 3-months follow up. The study reported an increase in the proportion of participants in the intervention group who had attempted to quit smoking at 3-months follow up, but this was not confirmed statistically. The study effectively demonstrated the feasibility of this intervention; however, the sample size of this study was too small to make conclusive statements regarding the efficacy of the intervention. Other limitations of the study included the restricted selection of the sample from a Paris university campus (limiting the generalisation of the findings). In terms of quality assessment, the paper was rated as weak overall, with selection bias and lack of information regarding confounders contributing to the global rating.

Song et al. (2013) conducted a quantitative investigation of an anti-smoking educational game created for social smokers, defined by self-report responses (‘Yes’ or ‘No’) to the question ‘are you a social smoker?’ Authors investigated a number of conditions in the game. Firstly, the effects of using pictures of the participants’ face to create a personal avatar (‘self-avatar’) compared to using another person’s picture (‘other avatar’). Secondly, a simulation

of the long-term consequences of smoking to the avatar's face ('future face' condition) was compared to not showing the long-term effects ('no future face' condition). Conditions were investigated in a 2x2 between subject's design. Participants (N = 62, 61.29% males) reporting smoking in the past 30 days were recruited from a Midwestern university in the US. Efficacy of the intervention was measured by assessing participants' attitudes, perceived risk, perceived susceptibility and intention to quit post intervention session. The results found that participants in the 'future face' condition experienced significantly stronger negative attitudes to smoking and a higher intention to quit compared to the 'no future face' condition. However, no differences were observed between the 'self-avatar' and 'other avatar' condition.

A strength of the research is the effort to draw attention to reducing smoking in social smokers, which has not been investigated to the same extent as other groups of smokers (Schane et al., 2009). The study also employed a robust 2x2 between-participants design that allowed for effective comparison of the different intervention conditions. Contrary to the reports provided by male smokers in Flett et al. (2017) who reported "personal relevance" was the most important factor to the success of a facial wrinkling intervention, the findings in Song et al.'s paper (2013) reported that in social smokers, the use of the self-avatar compared to other avatar did not increase negative attitudes towards smoking or intentions to quit. This suggests that showing the long-term consequences of smoking to the face (own or others) could be sufficient to affect smoking attitudes and intentions. However, this does not take into account how the participant may personally identify with the avatar creating a sense of personal risk. Limitations of the study included assessing only the immediate impact of the game and not long-term effects, as well as lack of investigation of the interactive virtual contextual element of the game and how this impacted on smoking attitudes and intentions. The research was assessed to be moderate in quality, with one weak rating (confounders) and one strong rating awarded (withdrawals and dropouts) hence a moderate rating was awarded overall.

3.3.2 Weight concern

Two of the papers retrieved aimed to help participants to quit smoking by reducing concern over post smoking cessation weight gain, which has been suggested to act as a barrier to smoking cessation (Germeroth and Levine, 2018).

Bloom et al. (2016) carried out a pilot investigation of the effects of a distress tolerance intervention for weight concern, among female smokers who attempted to quit. The intervention focused on helping the women to overcome fear of gaining weight as a consequence of quitting smoking and in turn increasing smoking cessation. All participants received the distress tolerance intervention from a trained professional, a standard smoking treatment and transdermal nicotine patches. Women (N = 11) received in total eight, 90-minute counselling sessions that were delivered before and after the set quit date. Eligible participants were aged 18-65, smoked at least ten cigarettes a day, were motivated to quit and concerned about post-cessation weight gain. Efficacy of the intervention was measured by self-report smoking abstinence, and biochemically verified by breath CO and saliva cotinine at 1-, 3- and 6- months post-intervention. Weight gain concern was measured using a body image questionnaire (Sandoz et al., 2013) and scale for depressive symptoms (Radloff, 1977). The study provides only descriptive statistics of the key findings, showing that by the end of the counselling sessions seven out of the eleven participants were abstinent from smoking, with only three participants maintaining abstinence at 1-, 3- and 6- months post-intervention. Results indicated that body dissatisfaction decreased directly after the intervention, but then steadily returned to baseline levels. The research was successful in investigating the feasibility of this novel intervention. The study however is limited due to the restricted, small sample size and lack of control group, elements that when included could help to assess in the full effects of weight concern on smoking cessation. The paper as a whole received a weak rating in terms of methodological quality, due to the ratings of confounders and blinding, preventing a higher rating from being awarded.

Bush et al. (2012) conducted an RCT evaluating the effectiveness of cognitive behavioural therapy (CBT), addressing smoking cessation related weight concern, incorporated into a tobacco quit-line service. Participants were randomised to one of two conditions. Condition one; a standard smoking quit-line service that included a quit smoking guide, five counselling calls with a quit counsellor and nicotine replacement therapy (n = 1000). Condition two; the same resources as condition one in addition to three more counselling calls and a weight concern program, consisting of weight concern content in the counselling calls (n = 1000). Male and female participants were recruited (ratio not reported) who were aged eighteen and above willing to quit within the next 30 days with a BMI of at least 18.5. Participants also expressed concern about gaining weight after quitting. Efficacy of the intervention (i.e., smoking abstinence) was measured by assessing self-reported cigarettes smoked per day. Participants in the weight concern program significantly decreased concern

regarding smoking weight gain and had less weight gain among quitters, compared to the standard quit-line condition. No significant differences between conditions were found in quit rates (quit rate at 90+ days post-intervention in responders: standard quit-line 22%, weight concerns program 23%). The study strengths were a blind design and the inclusion of a large sample size. A limitation of the study was the difference in the number of sessions for each intervention condition (three extra session were given in the weight concern programme). However, results regarding reduction in weight concern and weight gain among quitters remained significant after controlling for the number of sessions completed. This study provides the first evidence that weight concern treatment can be combined with smoking quit-line services with potential implications for public health. A moderate research quality rating was given to the paper, strong components were highlighted such as research design however this was let down by weaker elements such as withdrawals and dropouts.

3.4 Discussion

3.4.1 Summary of the findings

The current chapter aimed to assess the efficacy of smoking cessation interventions using physical appearance and to investigate the quality of research selected for review. The aim was achieved by performing a systematic review of the published research and performing quality assessment of research. Six papers using appearance based interventions for smoking cessation were identified. Four investigated the effectiveness of using facial wrinkling (three used software, and one a facial wrinkling game intervention) and two investigated a weight concern intervention, which differed on intervention length and type.

The findings of the four reviewed studies using a facial wrinkling intervention (Flett et al., 2017; Burford et al., 2013; Burford et al., 2017; Song et al., 2013) are mostly positive. However, it is important to note that one of the three quantitative studies (Burford et al., 2017) (even though the percent of participants that quit smoking was higher in the intervention (46%) vs control group (37%)) did not report significant results. Nevertheless, the small sample size reported prevents drawing a definite conclusion from this study. The fourth study (Flett et al., 2017) based on qualitative methodology without statistical comparison of intervention efficacy, provides supportive in-depth data regarding the experience of participants in the intervention. Out of the four papers, Burford et al. (2013), using robust RCT study design, provides the strongest evidence in support of the effectiveness of the intervention in changing smoking behaviour. Furthermore, Burford et al. (2013) results are consistent with findings from a previous RCT study, conducted in 2011

(and therefore not included within the articles reviewed here) which investigated the same intervention on female smokers (Grogan et al., 2011).

Support for the inclusion of weight concern interventions in smoking cessation programs was weak (Bloom et al., 2016; Bush et al., 2012). Out of the two weight concern intervention papers reviewed, one provided descriptive information (without statistical analysis) to suggest the intervention increased smoking abstinence (Bloom et al., 2016). The second paper, using a robust study design through a RCT and blind intervention outcome (Bush et al., 2012), found that compared to the control participants the intervention was effective in reducing weight concern in the intervention group, yet no significant differences were found in participant quit rates. However, all participants recruited were willing to quit within 30 days, and therefore it could be argued that weight gain concern (within this specific group of highly motivated participants) may not have acted as a prevalent barrier to quit. There is considerable variability in the experimental design between both articles, including type of counselling, participant inclusion criteria; with or without additional pharmacological treatment; gender differences between the samples (a female only sample in Bloom et al. (2016), and males and females without investigating possible gender differences in Bush et al. (2012)). With scarcity of research on this type of intervention, no conclusions could be drawn. Furthermore, an important aspect worth mentioning regarding the weight concern interventions implemented in the reviewed articles was that the interventions did not aim to reduce weight however there was continuous monitoring of the participants' weight throughout the experiment. This aspect of the research could have a negative impact on participants' body dissatisfaction as it draws the participants' attention to weight outcomes (Dionne and Davis, 2004), and could therefore counteract the coping strategies learnt in accepting weight concerns. Additionally, given that the study with the female sample found some support for the use of weight concern interventions, but not the study with males and females, future research could aim to fully investigate gender differences when using interventions that include reducing weight concern related smoking cessation.

The new studies that have emerged in the past six years indicate an increase in quality of research on appearance based interventions, adding to our understanding by providing more robust findings to support the efficacy of the interventions in changing smoking behaviour. A main strength of the quantitative research reviewed here was that all five studies included a control condition, in comparison to research previously reviewed (Flett et al., 2013), in which six out of ten papers did not include a control condition. Research quality of

quantitative papers included in this review assessing the efficacy of facial wrinkling intervention for smoking cessation was mostly rated as moderate (Table 2), rated higher than research reviewed in the previous review which was mostly rated as weak (Flett et al., 2013). The two weight concern papers were rated as 'weak' (Bloom et al., 2016) and 'moderate' (Bush et al., 2012) in terms of research quality (Table 2), while an overall weak quality rating assigned to research pre 2012 (Flett et al., 2013).

Though in general the quality of research on appearance based intervention has improved in comparison to the articles included in the review performed five years ago (Flett et al., 2013), still selection bias (Burford et al., 2017); control of confounding variables (Burford et al., 2013); and participant dropout (Bush et al., 2012) need to be addressed by future research (Table 2).

The majority of papers retrieved did not use a RCT design (Burford et al., 2017; Song et al., 2013; Bloom et al., 2016). An issue encountered while reviewing the selected articles is the variability in eligibility criteria, including variations between articles in age; smoking behaviour and gender. More importantly, this information was not present in some of the papers identified (Burford et al., 2017). Lastly the papers failed to report effect sizes for the efficacy of the interventions. This lack of consistency in the research regarding study design; measures; content of the intervention; outcome assessment and participants characteristics has prevented the combination of statistical data in a meta-analysis.

Similar to the previous review (Flett et al., 2013) and in general with long-term follow-up studies, dropout rates was a general limitation to the reviewed papers. This limitation is an issue in studies with long term follow-up measures where large proportions of participants did not complete the study in full (Burford et al., 2017; Bloom et al., 2016; Bush et al., 2012). Consistent with the previous review (Flett et al., 2013) Intent to Treat (ITT) analysis was used for the RCT research (Burford et al., 2013; Bush et al., 2012) meaning that participants who did not complete follow-up up measures due to drop-out had values imputed using various statistical methods. However, in contrast to the past research, ITT was used alongside responder analysis in some of the studies (Bush et al., 2012). This shows an improvement in study quality of recent research, as by excluding dropout participants from analysis in responder analysis, there is a reduced chance of making unconfirmed estimates of the smoking status of these participants (Armijo-Olivo et al., 2009).

3.4.2 Future directions

Future research should continue to design studies with robust methodology including control groups to increase validity of results. Measures should be described in more detail and discussed in terms of reliability. Research should also consider strategies to reduce participant attrition as to improve the power and confidence placed in research findings.

A number of protocol papers were identified during the review process. Three reported protocols for RCT's to be conducted within the next few years investigating both weight concern and facial wrinkling interventions for smoking (Faria et al., 2017; Brinker et al., 2016; Bush et al., 2016). This indicates research will continue to improve as suggested. A final consideration is the scarcity of qualitative research in this area. It would be useful to have more qualitative accounts of both facial wrinkling and weight concern interventions in order to inform future research protocols and the level of attrition. Overall, results suggest that appearance based interventions for smoking cessation are a promising tool. Especially, implementing facial wrinkling techniques into health settings (alongside more traditional health interventions) is highly recommended as it can be cost effective, as suggested in Burford et al. (2013) pharmacy setting study.

3.4.3 Limitations

A limitation of the review process is the inclusion of both short one session interventions (Burford et al., 2013; Burford et al., 2017; Flett et al., 2017; Song et al., 2013), and long multiple session interventions (Bloom et al., 2016; Bush et al., 2012). In addition to the use of the appearance based interventions as the only intervention (Burford et al., 2013; Burford et al., 2017; Flett et al., 2017; Song et al., 2013), or as a component of an intervention/programme (Bloom et al., 2016; Bush et al., 2012). Research suggests that physician-led interventions with more contact with the patients, led to better cessation outcomes (Ockene et al., 1991). This suggests the length of the intervention could impact on the efficacy (at short-term, and more importantly, long-term) of the intervention.

3.4.4 Conclusion

The new research that has emerged in the past six years indicate an increase in quality of research and provide increasingly robust findings to support the efficacy of interventions using appearance in changing smoking behaviour. Facial wrinkling interventions appear more effective in reducing smoking behaviours, intentions and attitudes than the weight concern reduction interventions. However, mixed findings have been reported. This may in

part be due to differences in intervention content, number of sessions, participant smoking behaviour, sociodemographic characteristics and geographical settings. Overall, study quality was moderate and areas for improvement for future research have been identified. The publication of well-designed RCT studies suggest appearance based (facial wrinkling) interventions for smoking cessation should be considered as an option for smoking cessation, though more research is still needed for investigating intervention efficacy in the long-term and identifying the population target for which the intervention will be most effective.

3.4.5 Additional appearance based intervention research

The above review assessed research investigating appearance based interventions published between 01/01/2012 and 22/05/2018. After the review was conducted, information gained from synthesis of findings were used to design and develop research protocol within the thesis. Discussed here are papers that did not match the inclusion criteria, or have been published since the review was conducted, which add to our understanding of appearance based interventions.

A number of recent papers not included in the review present research make use of phone based applications (apps). Apps incorporated both WGC reduction guided imagery tutorials in order for participants to reduce the amount of WGC they feel, in addition to monitoring of diet and physical activity (Giacobbi et al., 2016; Gordon et al., 2017; Schmidt et al., 2017). Limited information is presented as to the effectiveness of apps of this kind in reducing smoking behaviour, and limitations are present such as high attrition rates for app users. One WGC intervention published since the review (Bush et al., 2018) following from previous research (Bush et al., 2012) provided a published protocol before completing data collection (Bush et al., 2016). The paper (Bush et al., 2018) presents an RCT within a quit-line setting investigating the implementation of weight management information simultaneously and sequentially, to the standard quit-line intervention. The results indicated that the simultaneous approach produced the best outcomes for abstinence, which may be attributed to the higher levels of completed calls within the condition compared to others. Interventions that address WGC discussed here, add to overall findings concluded in the review. Through suggesting moderate effects can be observed, although issues with weight monitoring persist.

In terms of facial wrinkling interventions, papers that did not meet inclusion criteria or were published more recently show a focus towards prevention techniques rather than

interventions for current smokers (Faria et al., 2017; Brinker et al., 2018a; Brinker et al., 2016; Lisboa et al., 2019). These papers most commonly introduce a photo-ageing mobile app named 'Smokerface' utilising 'mirroring' a technique, in which a photograph is altered using the app and shared to a group of people. The app has been used in schools with children and adolescents of various ages (Brinker et al., 2016; Brinker et al., 2018a; Faria et al., 2017; Lisboa et al., 2019). A similar app has also been trailed within a clinical waiting room setting (Brinker et al., 2018b) as both intervention and prevention for smokers. Within these studies only a proportion of these participants were smokers, and no statistical information was provided on smoking outcomes. More recently published research on facial wrinkling techniques for smoking cessation therefore display a continuation in popularity of the technique in a range of settings.

In conclusion, research published since the present systematic review was conducted display a continuation in the focus on both WGC and facial wrinkling techniques for smoking cessation, showing promise for the development of intervention delivery. The majority of the papers however would not be reflected in the review search strategy, due to the preventative rather than interventionist strategy.

3.5 Chapter summary

The current chapter present a systematic review with narrative analysis, identifying appearance based interventions for smoking and evaluating their effectiveness in changing smoking outcomes. The review looks at literature from 2012 onwards following on from a systematic review covering years 1980 to 2012 by Flett et al. (2013), which retrieved eleven papers meeting the inclusion criteria, rated as mostly weak in quality. Eleven electronic databases were searched from 1st of January 2012 to the 22nd of May 2018. Abstracts, keywords and titles of publications were searched. A search strategy was developed relating to appearance based interventions for smoking. The strategy from the 2013 review was adapted, improving the accuracy of the search. Six papers met the inclusion criteria. Four interventions of moderate quality investigated a facial wrinkling intervention; two interventions of weak and moderate quality targeted weight concerns. Heterogeneity in the interventions and outcomes precluded meta-analysis. Four of the physical appearance interventions significantly reduced smoking, three of these papers investigated similar facial wrinkling interventions for smoking. Recommendations for research design improvements were taken into consideration in the design of later research within this thesis.

4 Chapter 4: Thesis rationale and aims.

4.1 Thesis rationale.

Smoking is the leading cause of preventable deaths in the UK (Office for National Statistics, 2019) and contributes to the economic burden of the country through expenditure of smoking related costs (Ekpu and Brown, 2015). The current evidence indicates that research with a focus on sex-specific smoking interventions are needed (Amos et al., 2012), which could support goals for a smoke free generation in the UK (Department of Health and Social Care, 2019). Men and women have sex specific factors relating to tobacco addiction and smoking behaviour which include differences in psycho-pharmacological, social and environmental contextual factors (Smith et al., 2016). Interventions that can provide sex specific benefits for the needs of men or women who smoke may increase efficacy of smoking cessation.

Women report greater positive affect of smoking compared to men (Perkins et al., 2006) and are more sensitive to the rewarding effects of smoking (Perkins, 2009). This greater sense of the rewarding effects of nicotine in women indicates that women have increased difficulty in making and sustaining a quit attempt. Interventions that increase women's motivation to quit could help to reduce the positive associations made with cigarette smoking, and induce changes in smoking behaviour (McClernon et al., 2008).

Furthermore, research focused on women is a priority in order to improve motivation for smoking cessation, due to the specific health risks related to smoking behaviour women encounter (Huxley and Woodward, 2011; Luo et al., 2011). These risks include, greater risk of heart disease than men (Huxley and Woodward, 2011), and contracting cancer types more commonly seen in women (e.g. breast cancer) (Luo et al., 2011). Additionally, women of reproductive age who wish to have children, could encounter increased problems in fertility and greater chance of ectopic pregnancy (Action on Smoking and Health, 2018). Furthermore, smoking behaviour in pregnant women is associated with reduced head size and weight of the foetus, creating further complications in later life (Abraham et al., 2017). The sum of risk of smoking in women therefore indicates greater emphasis should be placed on interventions that can produce motivational changes and aid smoking cessation in women.

Age-progression interventions for smoking cessation have been indicated as effective in increasing i) quit smoking motivation in women (Flett et al., 2013), ii) quit smoking intentions (Flett et al., 2017; Grogan et al., 2011; Grogan et al., 2010b), and iii) reductions in smoking behaviour (Burford et al., 2013). The intervention highlights the effect of

smoking on the skin, while also emphasising the health impact of smoking within a brief intervention form. The method provides a cost-effective technique, alternative to other brief traditional health approaches (Flett et al., 2013). Systematic review findings (Chapter 3) indicated that age-progression interventions increased efficacy over solely health information. The combination of both health and appearance components is therefore suggested to be a compelling combination for smoking cessation in women.

Interestingly, qualitative research has consistently reported a shock reaction to age-progression intervention images (Persson et al., 2018a; Flett et al., 2017; Grogan et al., 2010b). Specifically, in research with women smokers, women expressed shock and stress in seeing their own face aged with the effects of smoking, and importantly, this shock reaction was related to accounts of intentions to quit following intervention delivery (Grogan et al., 2010b). This physiological arousal of the stress response is characterised by activation of the SNS (Godoy et al., 2018); e.g., increased HR and sweating to enable the body to respond to the threat (McEwen, 2006). The SNS response to mild or moderate stress has been implicated in increasing working memory and emotional capacity (Corbett et al., 2017). While previous research into fear appeal methods for smoking cessation, provides contrasting arguments as to the optimal levels of stress and fear needed to induce behaviour change. With some researchers supporting a linear model of behaviour change, in which the higher the level of fear and stress induced, the greater the changes in smoking behaviour are (Cho et al., 2018; Hammond, 2011; Mongeau, 1998). While other researchers have evidenced the curvilinear approach, in which moderate levels of stress are viewed as optimal, as they reduce defensive and avoidant behaviour to intervention messages (Dillard et al., 2017). Information regarding the impact of the stress response on cognitions and smoking behaviour has led to the development of the thesis rationale. When stress is elicited by the shock of viewing the age-progression intervention images, this response could serve to increase participants motivation to stop smoking. However, the level of stress required is unknown.

The empirical work within this thesis aims to investigate the role this stress response (associated to the shock reaction) plays in the success of the intervention. Firstly, in order to assess if increased stress did relate to better intervention outcomes, manipulation of the intervention delivery was required, to induce a differential stress response to the intervention. Two intervention instructions were developed. The Neutral instructions were designed to maintain the level of stress, and the Reassuring instructions were designed to

decrease the stress response. To capture the physiological reactivity elicited by the intervention and instructions, measurements of the electrodermal activity (EDA) and heart rate (HR) were selected. These measures are biomarkers of the rapid changes of the SNS in stress response (Posada-Quintero et al., 2018). This approach has been widely used in research to measure levels of stress elicited by specific stimuli (e.g. threat elicited in response to graphic warning images (Droulers et al., 2017), among others, for review see Kreibig (2010)).

Activation of the SNS stimulates sudoriparous glands (Gómez-Amor et al., 1990) and sweat release. The increased amount of water affects the electrical properties of the skin by decreasing its resistance. Sympathetic arousal has been related to changes in emotional states, including stress (Visnovcova et al., 2016) and surprise or shock (Jang et al., 2015). Hence, EDA was selected as a proxy to investigate the SNS reactivity towards the intervention morphed images, providing an objective measure of the stress experienced (Boucsein, 2012).

In addition to EDA, the measurement of HR was obtained through photoplethysmography (PPG) (optical technique used to detect changes in blood circulation). Increases in SNS activity increases cardiovascular reactivity, due to increased metabolic demand in times of threat or short-term stress (Hjemdahl et al., 1989). Previous research has implemented measurements of HR to capture stress responses to experimental induction of stress and worry (Fisher and Newman, 2013; Schubert et al., 2009). Heart rate measurement through PPG techniques was utilised alongside EDA measurement within this thesis, to provide a second objective measurement of SNS short-term stress.

Even though both, EDA and HR were selected in this thesis as a non-invasive and convenient measurement of short-term stress (Elgendi, 2012), the use of this equipment has not previously been combined with an age-progression intervention in the literature. Consequently, work within this thesis sought to assess if by adding these measures it could distract from or interfere with the delivery of intervention and its efficacy. Additionally, the expected manipulation of the stress response with the use of the newly designed verbal instructions (Neutral and Reassuring) needed to be tested. Therefore, a pilot investigation with a mixed methods approach was performed. This mixed methods approach was adopted to capture both, qualitative accounts from participants on their reaction to the implementation of stress measurement, and quantitative measurement of the stress response.

In addition, quantitative methods were used to assess the attrition of participants, in order to optimise the best methods for participant retention. Both halves of the mixed methods pilot investigation fed into the design and execution of an RCT. The RCT study was used to investigate the efficacy of the age-progression intervention delivered via the verbal instructions in comparison to a control intervention arm, and assess the role of the stress response. Below outlines the aims and objectives for all empirical work within this thesis.

4.2 Aims and objectives

4.2.1 Systematic review

A systematic review was performed to assess the literature on appearance based interventions for smoking cessation; suggestions and limitations from the findings of the systematic review were taken into account in the design of later research.

The first and only review of appearance based interventions for smoking cessation was published in 2013 (Flett et al.). Given the length of time since that last review (the literature search was performed between 1980-2012, (Flett et al., 2013)) and the starting point of the current project (2017), at a time when the emergence of new appearance based technology has been made accessible to the general public and an updated understanding of the use of this technology in smoking cessation interventions was needed.

The systematic review aimed to assess the efficacy of smoking cessation interventions using physical appearance, and to appraise the quality of the identified research. Implications of this review are outlined for future research in this area. The objective was to perform a systematic review to assess articles that investigated appearance based interventions for smoking cessation, published between 2012 and 2017. Once the search process had been completed decisions over the synthesis of results were made. Due to the heterogeneity of the interventions identified, which precluded the implementation of a meta-analyses, a narrative synthesis was performed in addition to the quality assessment of the papers included in the review. The search process, narrative synthesis of results and quality assessment are presented in Chapter 3.

4.2.2 Pilot mixed method investigation of the age-progression intervention protocol.

A pilot mixed method investigation of women's reactions to an age-progression intervention was designed to test feasibility of adding physiological stress measurements to the protocol. Additionally, the study developed the procedure for the implementation of i) two types of

instructions for the age-progression intervention, in order to elicit different levels of stress, and ii) the inclusion of physiological and subjective measurements of the stress response. Participants' suggestions obtained through interviews and focus groups were incorporated progressively to improve and adjust the protocol following a three block-step model. Additionally, data from participants during the pilot investigation was used to provide information on the experiences of women engaging with the intervention.

Qualitative aims of the pilot investigation included:

1. To assess participants perceptions of the research protocol and explore how the protocol could be improved through the block-step model.
2. To explore the experiences of women aged 18-55 years who smoke, given an age-progression facial morphing intervention through either Neutral or Reassuring instruction types.

Quantitative aims of the pilot investigation included:

1. To investigate if the intervention increased physiological and subjective stress, and whether the type of instructions provided during the intervention would affect differentially the stress response.
2. To assess the feasibility of the data collection plan, through monitoring recruitment and retention of participants.
3. To gather exploratory information regarding the efficacy of the intervention.

In order to achieve the aims of qualitative and quantitative components of the pilot, the protocol was developed in three stages, requiring the following objectives to be met:

- Design of intervention instructions to elicit a differential stress response. Instructions used in previous research gained through personal communication with the author (Grogan et al., 2011; Grogan et al., 2010b) were used as a starting point to create the Neutral instructions, and the Reassuring instructions were developed by adding reassuring phrases and gestures.
- Participants were block randomised to receive the Neutral or Reassuring instruction, within block-step model of recruitment.
- Focus groups and interviews were conducted and used to investigate the experiences of participants exposed to the research protocol and intervention.
- Physiological arousal was measured using EDA and HR to assess the reactivity to the intervention and instruction types.

- Information regarding completion of follow up questionnaires was gathered at post-intervention time points (1-, 3- and 6-months) and assessed for rates of study completion.
- Exploratory information regarding smoking outcomes was gathered over data collection time points to explore the efficacy of the intervention.

Methodology including design, measures and analysis for the pilot investigation are reported in Chapter 5. The findings from this investigation are subsequently reported in three individual chapters (Chapters 6 for the qualitative protocol development, Chapter 7 for the additional exploration of the intervention experience and Chapter 8 quantitative pilot findings).

4.2.3 Randomised Controlled Trail (RCT) with longitudinal investigation of the impact of the intervention.

An RCT design was implemented to investigate the impact of the intervention condition on smoking outcomes. Three Intervention arms were implemented: two age-progression interventions arms (intervention delivered using Neutral instructions and intervention delivered using Reassuring instructions), both accompanied by stop smoking information, as tested in the pilot study. The third arm was a Control intervention, including a control task and the same stop smoking information as delivered in the age-progression intervention arms.

A number of aims are outlined in order to investigate the impact of the intervention on smoking outcomes and the role of the stress response. Aims reflect the explorations of the impact of measures of stress, and other potentially moderating or mediating variables on the intervention outcomes.

The aims are outlined below.

1. To assess the impact of the age-progression intervention conditions (Control, Neutral and Reassuring) on smoking outcomes.
2. To investigate the impact of the intervention condition on levels of subjective and physiological stress, measured at baseline and during the intervention.
3. To investigate the mediating and moderating effects of the stress response on the short and long-term outcomes of the intervention.
4. To assess the effects of other potential moderating variables (such as, anxiety, depression, appearance orientation etc.) on the intervention efficacy.

In order to achieve the study aims the following objectives were set:

- In order to evaluate the intervention efficacy, changes in smoking outcomes from pre- to post-intervention time points were assessed between intervention arms (Control, Neutral and Reassuring).
- In order to investigate the impact of the intervention arms on levels of subjective and physiological stress reactivity, stress responses were measured in all conditions. These responses were compared between conditions and from baseline to during intervention time points.
- In order to assess the mediating and moderating role of both, the stress response and other potential moderating variables on smoking outcomes, moderation and mediation models were assessed. Smoking outcomes observed to have been influenced by arm delivery were entered into moderation and mediation models as the outcome with the corresponding moderator or mediator variables to assess if significant models could be observed.

5 Chapter 5: Methodology

5.1 Chapter introduction

This chapter describes the methods of data collection and analyses that were used throughout this thesis. The design adopts a mixed methods approach, through combining both quantitative and qualitative methods and approaches to data collection and analysis (Tashakkori and Creswell, 2007). Due to the requirements and aims of the thesis, this chapter will argue for the suitability of this mixed methods approach for investigating the complex research questions (Dures et al., 2011). The different methodologies adopted for each section of the empirical work are outlined. This includes: i) the materials used to implement the age-progression intervention and control activity, ii) the qualitative methodology used including theoretical positioning, interview and focus group protocol, and thematic analysis method utilised for data analysis (Braun and Clarke, 2006), and iii) the quantitative data collection approaches, including study design, questionnaires administered, and use of physiological measurement equipment.

5.2 Research methodologies

5.2.1 Mixed methods approach

A mixed methods approach to research is increasingly being used as an alternative to more traditional solely quantitative or qualitative methods (Tashakkori and Creswell, 2007). The approach is defined through the use of both quantitative and qualitative methods within one research project (Johnson and Onwuegbuzie, 2004), with clear designation of priority and order given to each element (Denscombe, 2008). It has sometimes been assumed by researchers that qualitative and quantitative methods are incompatible in their paradigm, due to different assumptions of ontology and epistemology. Mixed methods research does not dispute these differences, instead it acknowledges the understanding that there are multiple ways of making sense of the world, therefore by including more than one perspective we can broaden our knowledge (Greene, 2008).

Shared aims of both quantitative and qualitative research include looking at relationships and examining links. Therefore, utilising a mixed methods approach can be considered a powerful third research paradigm choice (Johnson and Onwuegbuzie, 2004) that will provide the most informative complete results (Johnson et al., 2007). The philosophy of pragmatism underpins mixed methods research (Johnson and Onwuegbuzie, 2004), as pragmatists state that practical consequences are a vital component to truth and meaning. Pragmatism allows researchers to draw on both qualitative and quantitative elements, in order to choose the

method that best suits the situation and research question (Johnson and Onwuegbuzie, 2004). The focus here is not on the method, but the intended consequence of the research, that a mixed approach will help to achieve (Creswell and Creswell, 2018).

Mixed methods designs have increasingly been used within health research in order to investigate the complex nature of health behaviours (Dures et al., 2011; O'Cathain, 2009). When investigating health interventions, qualitative data is most commonly collected in support of developing the intervention in question, which can then be tested through quantitative methods (Fetters et al., 2013). Therefore, a mixed methods approach was chosen for the pilot study, due to aims of the research. These aims included assessing sets of instructions to be used during the intervention that were designed to induce different levels of physiological reactivity requiring a quantitative approach, as well as gaining insight in relation to the experience and attitudes towards the intervention upon smoking behaviour and impact of the research protocol (aim achieved through qualitative methods). Findings from both, qualitative and quantitative analyses of the pilot and qualitative investigation were drawn upon to inform the development of the final quantitative RCT.

Two main rationales are proposed for conducting mixed methods research within this thesis, informed by Greene et al. (1989). Firstly, a 'complementarity' approach is needed in which qualitative methods are used in tandem with quantitative methods in order to elaborate and enhance understanding of data gained from each method. The pilot utilises a convergent parallel methods design in order to achieve the complimentary approach, in which both qualitative (through interviews and focus groups) and quantitative (through self-report and physiological measurements) methods are used i) to assess the feasibility of the experimental protocol (quantitative approach) and ii) to understand participants experiences of the intervention and instruction type using the qualitative approach. The design allowed for the collection of two different perspectives of the research, drawn from the same set of participants. Furthermore, an exploratory sequential mixed methods design was implemented in which qualitative data (interviews and focus groups) from the qualitative investigation and pilot (based on participants' experiences of the intervention and protocol development) was then used to inform the design of the quantitative RCT data collection.

5.2.2 Epistemological approach

The epistemological approach chosen within this thesis is critical realism. Realism is concerned with the generation of knowledge that truthfully reflects events in the real world

(McEvoy and Richards, 2003). Realism assumes that this truth exists independently of researchers' and participants' views. In addition, the approach assumes that social and/or psychological processes exist and can be identified (Willig and Stainton-Rogers, 2017). Critical realism goes beyond traditional realism perspectives, by assuming that the data generated in the research does not directly reveal the truth, instead interpretation needs to occur, to facilitate understanding the of underlying concepts and mechanisms making it an effective perspective for health and behaviour change research (McEvoy and Richards, 2003). The approach as a whole recognises that the knowledge produced is situated within a social and psychological structure, and therefore cannot be truly objective (Chamberlain, 2015). A critical realist approach is used in this thesis due to the compatibility of the approach to both qualitative and quantitative research methodologies presented within mixed methods design (Scott, 2007). The approach allows for the quantitative and qualitative methods with different ontological bases to focus on the same research problem and produce similar and supportive conclusions.

5.3 Research design

Two different sets of data were gathered within this thesis, relating to three related pieces of research. Each comprise of different research design aspects, all of which are outlined below.

5.3.1 Pilot

The pilot study is the first empirical research study of the thesis. The design and methodology of the study reflect aims of testing the feasibility of data collection and developing the research protocol for implementation to a larger scale RCT design study. The pilot study utilised both qualitative and quantitative methodologies through a mixed methods design, as outlined above.

5.3.1.1 Protocol development design

Qualitative design aspects including semi-structured interviews and focus groups, were combined and analysed using thematic analysis techniques within the pilot for the development of the research protocol. A block recruitment design was introduced to accomplish the protocol development. Participants were recruited in blocks of ten with equal number of participants allocated to each instruction type (Neutral = 5 and Reassuring = 5). Changes to the protocol were added after each block of data collection which included the intervention administration, individual interviews conducted in all participants directly after the intervention session, and lastly the focus groups conducted no later than four weeks after

the initial intervention procedure. Participants were invited back to take part in the focus groups with participants within the same instruction type condition. Once the focus groups were conducted (not all participants within each block returned to take part), qualitative analysis of the combined qualitative data took place to identify how the protocol could be developed. Changes to the protocol were implemented for the next block of recruitment, which was repeated for all three blocks of the pilot.

5.3.1.2 Quantitative pilot research

Quantitative aspects to the pilot research employed a two-way repeated measures design. This design included the two instruction types (Neutral vs Reassuring) and the repeated measure of time, through measurements at pre-intervention (pre-), immediately post-intervention (post-), and at one- (1-), three- (3-) and six- (6-) months post-intervention. Unlike the protocol development, all quantitative data was combined at the end of the third and final block of recruitment before analysis commenced.

5.3.1.3 Additional qualitative exploration of women's experiences of the intervention

An additional qualitative exploration was conducted, using data obtained from the interviews and focus groups gathered in the pilot study. The design reflects the aim of exploring the experiences of women who were administered the intervention within the instruction types. As in the protocol development, data from both interviews and focus groups were analysed using thematic analysis techniques. Unlike the protocol development, analysis of the responses outlining the experience of the intervention were combined and analysed following the completion of the third recruitment block

5.3.2 Randomised controlled trial

The RCT design allows researchers to balance external factors between groups, allowing the impact of the intervention to be detected (Stephenson and Imrie, 1998). Because of the control for bias, RCTs are considered an effective and appropriate method to help understand the efficacy of complex behavioural interventions (Black, 1994). An RCT research design was utilised within this thesis in order to assess the effect of the age-progression on smoking outcomes and explore the influence of the stress response.

The study implemented a pragmatic, three-arm parallel groups RCT. The design included two active intervention arms for the age-progression intervention (Neutral and Reassuring), both plus a stop smoking information leaflet. Information regarding the intervention

instruction and stop smoking information leaflet are outlined in sections below. The comparison Control intervention arm included a control task and the same leaflet as in the intervention arms. Design included participants' checks for eligibility, randomisation, intervention/control completion and follow up data collection time points at 1-, 3- and 6-months post-intervention session.

5.4 Qualitative approach

A qualitative approach was used in the pilot protocol development and additional qualitative exploration, consisting of individual interviews and small focus groups with women aged 18-55 who had experienced the intervention with either, the Neutral or Reassuring instruction type. Qualitative research is a useful tool for gaining insight into human behaviour (Willig and Stainton-Rogers, 2017); more specifically it has been used to understand behaviour change interventions for health-related behaviours, including recent interventions for smoking cessation (Granado-Font et al., 2018; Tudor-Sfetea et al., 2018; Spears et al., 2019).

Qualitative research has previously explored attitudes towards age-progression facial morphing interventions for health behaviours including smoking, sun damage and alcohol use (Flett et al., 2017; Owen et al., 2019; Grogan et al., 2010b). In spite of its use in previous research, in the systematic review, it was pointed out that qualitative research regarding the use of this intervention is still scarce (Chapter 3). Recommendations were made for use of qualitative research in the future to enable identification of target audiences and develop ways in which the intervention can most effectively be delivered to promote behaviour change. Further to understanding the perceptions of an intervention, qualitative research has been used to develop and improve interventions (Michie et al., 2015). Recommendations are made for the inclusion of qualitative research in the development of RCT protocols through pilot research, as a tool to optimise intervention and trial conduct (Cathain et al., 2013). Following these recommendations, qualitative methods were included in this thesis in order to inform protocol and research practice in the RCT and understand participants' experiences of the intervention.

A combination of qualitative methods, consisting of individual interviews and focus group discussions were utilised. Focus groups allow for the inclusion of group interaction to produce research data (Oates, 2000), while individual interviews allow for exploration of ideas and responses from one individual (Gill et al., 2008). Both methods of data collection

were implemented in order to explore individual accounts and enrich the conceptualisation of the experience of the intervention, enhancing trustworthiness of data obtained from each (Lambert and Loiselle, 2008). This combination of data sources is effective as part of the triangulation method of data collection in which results from more than once source can help to generalise findings (Lunt and Livingstone, 1996). Therefore, individual interview sessions were needed in addition to focus groups, to fully explore the feelings and accounts of the women towards the intervention images and protocol.

5.4.1 Semi-structured interviews

The semi-structured format of the interviews is most commonly used in health research, as it provides a flexible framework to discuss the topic under consideration (Marks and Yardley, 2004). Semi-structured interviews include several key questions used to define areas to explore with the participants, facilitating insight into how participants spontaneously construct an issue or topic, which more structured methods would be less likely to capture (Marks and Yardley, 2004). This flexibility in questioning allows the researcher to use an interactional conversational style, which is useful to explore ideas and responses in detail when the participants deviate from the pre-designed questions around the topic (Gill et al., 2008). This can be accomplished, while managing the quality of the data produced (Willig and Stainton-Rogers, 2017), within the semi structured interview format.

5.4.1.1 Interview protocol.

A protocol was developed to gain rich interview data from participants within all blocks of the pilot study data collection. In all participants, at the end of the intervention session, participants were administered a semi-structured interview. Firstly, participants were asked if they were sitting comfortably and happy for the interview part of the session to begin. A script was read out to the participant, including information about the topics to be covered in the interview and information on the anonymity of their responses, allowing the participants to speak freely throughout the interview. Participants were also reminded that the interviews were recorded for transcription purposes (see Interview Script, Appendix 2).

Based on topics covered in previous age-progression intervention research (Grogan et al., 2010b; Flett et al., 2017), the interview questions explored attitudes (e.g. "*what did you think about the intervention*") and feelings (e.g. "*how did you feel when you were doing it?")* towards the intervention, including impact on smoking behaviour. Some questions included in previous research were adjusted in order to cover topics related to the new measures

incorporated in the intervention (self-report and physiological data) allowing for data to inform the development of the research protocol (for example, "*What did you think about the questionnaire?", "is there anything we could have done to make this part of the study more comfortable for you?")* (Appendix 2). In line with Spradley (2016) suggestions for interview format, interview topics covered both aspects, descriptive (asking participants to talk about their general views on what happened during the intervention session) and evaluation (questions concerning the feelings of participants towards the intervention and protocol), allowing the retrieval of in depth data from participants.

The interview schedule was printed on paper and placed near the researcher for reference. A funnelling technique (Smith, 2015) was adopted, in which if the researcher felt greater detail was needed from the participant in response to a question, appropriate prompts were used e.g., personalising the question (*"I understand that [participant own words]*") or asking for clarification of the participants meaning *("can you describe what you mean by saying [participant own words]?*"). Prompts allowed for a greater depth of data to be obtained (Smith, 2015). Towards the end of the interview, participants were asked if they had anything else to add to their responses and thanked for their time. A partial debrief was delivered about the study session (note that given the longitudinal nature of the study the full or total debrief was provided at the last point of data collection), and participants were invited to take part in focus group discussions and complete follow up questionnaires at a later time point.

5.4.2 Focus groups

Focus groups have been defined as group discussions that can explore sets of issues or topics (Kitzinger, 1995). Focus groups are arranged to discuss a specific topic within a group setting with participants that share an experience or have previously engaged in a similar activity (Oates, 2000). Researchers take on the role of moderator in which they gently steer the direction of conversation (Willig and Stainton-Rogers, 2017). In the present focus groups, participants discussed the shared experience of receiving the age-progression smoking intervention and participating in the research study. Focus groups added to the data acquired from individual interviews, as they aimed to replicate natural conversation during social interaction, going beyond the unnatural act of the individual interview process (Hennink, 2007).

Research suggests that focus groups can work successfully with as few as three participants and as many as fourteen (Stewart and Shamdasani, 2014). Similar to previous research on appearance related intervention research in adults (Grogan et al., 2010), focus groups were populated with 2-4 participants. Due to the sensitive nature of the topics being discussed, small sized groups were preferred to provide all the participants with time and space to feel able to disclose sensitive information (e.g., participants discussed health, body image, ageing concerns) and remain comfortable (Morgan, 1996).

5.4.2.1 Focus group protocol

Participants were invited back to take part in focus group discussion within one month of taking part in the initial session, alongside participants within the same instruction type and block of recruitment (see below for more details regarding instruction type and block recruitment). A script outlining the focus group procedure was developed and used for reference by the researcher during focus groups sessions (Appendix 3).

Firstly, participants were welcomed and thanked for returning to take part in the focus groups. They were reminded that the researcher was interested in what they had to say, regardless of whether they agreed or disagreed with the other participants' opinions. Participants were then reminded what the purpose of the focus group was. General guidelines were introduced telling participants that they did not need to speak in any particular order and that it was important that points of view from each participant were obtained. Lastly, although participants could disagree with each other, they were asked to refrain from devaluing comments from other participants, or making negative comments aimed at another participant and discouraging them to intervene in the conversation. These guidelines were outlined at the start in order to make participants aware of the importance of all participants contributing to the discussion and to set a level of respect, enabling an open and honest conversation (Smith, 2015).

As a form of introduction and to facilitate interaction, participants were asked to write their preferred pseudonym on a post-it note and place it in front of themselves. This enabled the participants to address each other by pseudonym preserving anonymity in the recordings and transcriptions. The researcher then asked the participants to remember and try to visualise what had happened at the intervention session. This visualisation was supported through displaying the researcher's own image, morphed with the age-progression facial morphing software, printed full size on a A4 paper. The introduction of images into a focus group

setting has previously been found effective in health research to trigger participants' responses towards complex behavioural processes (Gong et al., 2012; Smith, 2015).

The same questions introduced in the one-to-one interview setting were utilised for the focus group discussion (Appendix 1); this allowed for the researchers to reflect upon and analyse the original responses in the interview and the responses and elaborations during the discussion, as part of the triangulation method of data collection (Lunt and Livingstone, 1996). If not all the participants had spoken in response to a topic, the researcher would address them directly to ask for their input. At the end of the focus group, the researcher summarised the questions and responses from participants asking if they had anything to add to the summary. Participants were then reminded of their anonymity during the transcription and analysis process, and that follow up questionnaires would be sent with a final debrief at the 6- month point. Lastly, they were thanked again for their participation. Data collection did not progress to the next block of the pilot, until focus groups were completed or participants were given opportunity to decline participation.

5.5 Quantitative research methodology

A quantitative approach has been utilised in both, the pilot and RCT. This consists a two-way repeated measures design with block recruitment in the pilot and longitudinal three-arm parallel groups design for the RCT. Both of which incorporated self-report questionnaires and measures of the stress response.

A quantitative approach is suitable for the measurement of human behaviour and investigating the impact of introducing behaviour change interventions (Neuman, 2014). Both, exploratory and hypothesis driven quantitative research were undertaken within this thesis. Exploratory to firstly develop and assess feasibility aspects of the measures, followed by hypothesis driven to infer causality (Jebb et al., 2017). All measures outlined below were used in both studies unless stated otherwise.

5.5.1 Materials

5.5.1.1 Intervention- age-progression facial morphing intervention.

The age-progression facial morphing intervention implemented in this research was the APRIL® software (Version 2.7; APRIL Inc., 2018). By taking a photograph of an individual's face, and considering physical features such as age, ethnicity and gender, the software illustrates how a person is likely to age up to the age 72 using a 2D (Fig. 4) and a

3D mask (Fig. 5). Brightness and contrast filters are applied as necessary. Facial features detection points (e.g., mouth, eyes, etc.) are manually matched between the participant's picture and the stock image (Fig. 3). The software displays a time progression of the ageing process on the individuals' photograph. On the left-hand side of the screen, the intervention displays ageing without the effects of smoking following the natural ageing process; on the right-hand side the effects of smoking on the ageing process are displayed (Fig. 4 and 5). The wrinkling effects of smoking are based on average ageing characteristics taken from a database of 3D scans of smokers (APRIL Inc, 2018). Women participants were shown both 2D and 3D morphed images, found previously to optimise impact of the intervention in smoking (Flett et al., 2017; Grogan et al., 2011; Grogan et al., 2010b) and other health behaviours such as sun damage, (Persson et al., 2018b) obesity (Roockley, 2014) and alcohol drinking behaviour (Owen et al., 2019).

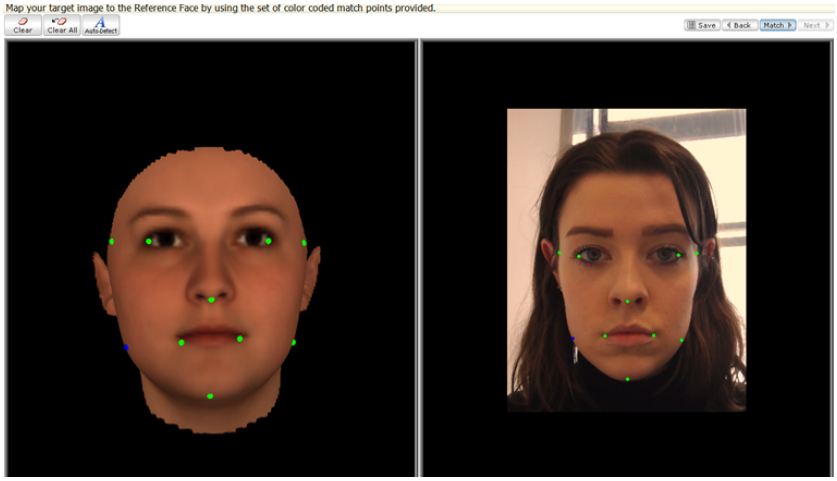

Figure 3 *Screenshot of the age-progression intervention software, showing the matching process of stock image.*
Note: Stock image (left side) is matched to a person's image (right side) using software's detection points (green points) of facial landmarks (location of eyes, lips, chin, and face shape).

In both studies, the cigarette exposure option was chosen to be displayed on the right-hand side image, enabling direct comparison with the natural ageing image on the left. The general process for the intervention included taking a facial picture of the participant with a neutral expression (using a device built in camera) and uploading the picture to the software. Following the calibration and setup procedure as explained above the participants were shown two identical images of their original photograph in 2D (Fig. 4), with the addition of the 3D mask (Fig. 5). A sliding bar and play/pause features of the software located at the bottom of the screen were used to manually move between the images displaying different ages in a progression, ranging from the participants' age at the time of the intervention to the age 72.

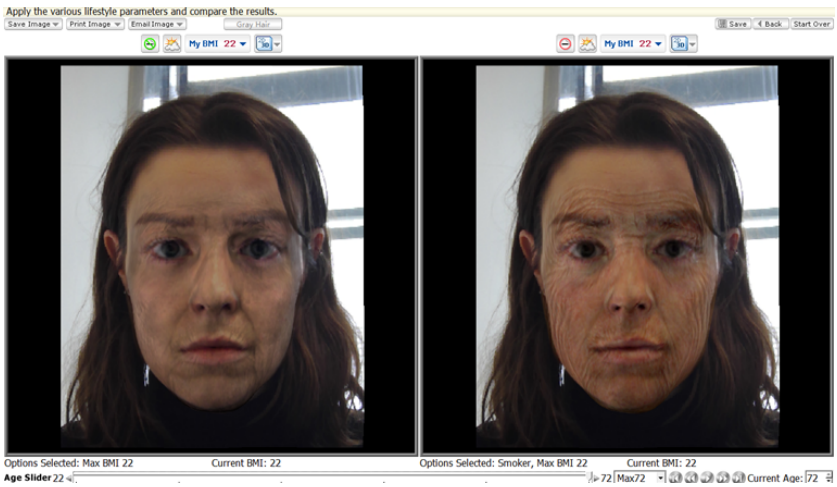

Figure 4 *Screenshot of the age-progression intervention software, showing 2D -morphed images aged 72*
Note: Image displays non-smoking (left image) and smoking (right image) effects.

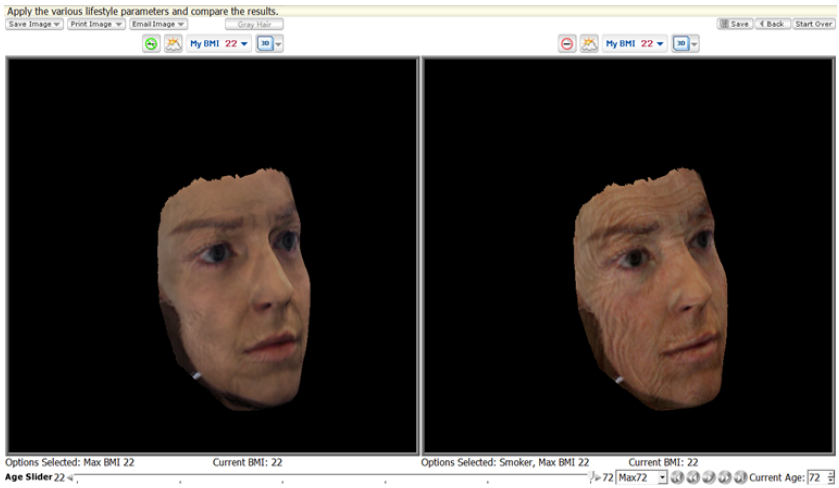

Figure 5 *Screenshot of the age-progression intervention software, display of 3D image, aged 72*
Note: 3D non-smoking (left image) versus 3D smoking (right image).

The intervention duration was approximately 10 minutes, including five stages. Stage 1: the participants were asked to close their eyes while the software automatically morphed the images up to age 72 (this process required 2-5 seconds depending on participant's age). Stage 2: the participants were instructed to open their eyes and notice the difference between the two images displayed on the screen (left side–natural ageing without smoking-, right side–including the effects of smoking on ageing process; Morph2D) which takes on average 30 seconds. Stage 3: the participants were shown the full morphing sequence in 2D (Morph2D_R). The progression of ageing during Morph2D_R also occurs within 2-5 seconds; therefore, this sequence was repeated a second time (Morph2D_R'). Stage 4: the participants were shown the morphing sequence of both ageing images (with and without smoking effects) in a 3D view (Morph3D). Morph3D was repeated a second time in order for the participant to notice the difference in ageing between the two images (Morph3D_R).

Participants were given the opportunity to move the 3D image on the screen for both Morph3D and Morph3D_R which lasted on average between 40-50 seconds. Stage 5 ("Freetime"): this phase was only introduced in the second and third blocks of the pilot and all of the RCT. The Freetime phase included a period at the end of the intervention in which participants were instructed to freely use the sliding bar at the bottom of the screen in order to view any age within the morphing sequence. The total amount of time the participants engaged in the Freetime phase was between 21 and 198 seconds. Given the differences between participants in the range of time spent in the Freetime phase, this phase was not included in the analyses.

5.5.1.2 Intervention instruction type conditions.

Two instruction types were developed to be delivered by the researcher accompanying the age-progression intervention for smoking cessation, with the aim of modifying the level of stress (Appendix 4). Instruction types, Neutral and Reassuring, were introduced and trialled within the pilot study and later utilised further in the RCT.

Neutral instruction: this instruction included only essential interactions between researcher and participant, in order to minimise any researcher effect on the participant's response to the intervention. Accordingly, the instructions were designed to minimise their impact on the shock reaction induced by the intervention images (e.g. "*please can you close your eyes and open them when I tell you to, you will see your face aged to 72*"). These instructions were delivered by the researcher in a neutral voice with corresponding neutral facial expression.

Reassuring instruction: the instructions followed the same basic instructional statement as in the Neutral, with the addition of reassuring phrases (e.g. '*do not be alarmed it is just the morphing process*') and gestures (e.g. empathetic smile) from the researcher. This instruction type was designed to reduce the impact the intervention has on the stress response of the participants.

5.5.1.3 Control

The Control task and intervention outlined below was implemented in the RCT as a third control arm of the trial. The systematic review of previous appearance based intervention for smoking cessation research (see Chapter 3) indicated control or usual care conditions often include less face to face time with participants, equating to an imbalance between condition

types (Burford et al., 2013; Grogan et al., 2011). Therefore, an equivalent visual and computer-based task to the intervention was developed as a control task. The task was based on a "spot the difference" game, mirroring the intervention, through use of comparison between the two images presented side by side on the screen. The researcher sourced images (in line with the fair use of images for educational and research purposes) (Sweethearts®, 2017), which did not include images related to smoking, health or appearance, formatted for purposes of the task. (see Fig.6-8).

Five pairs of images were selected to match the five morphing sequences presented in the intervention condition (Morph2D - Pic 1, Morph2D_R - Pic 2, Morph2D_R'- Pic 3, Morph3D - Pic 4 and Morph3D_R - Pic 5). At the beginning of the task the participants were informed that they had to spend at least ten minutes completing the task. Instructions for the spot the difference task were displayed on the screen and read aloud to participants before beginning the task, informing participants that the task was not an assessment and no time limits were in place (Fig. 6).

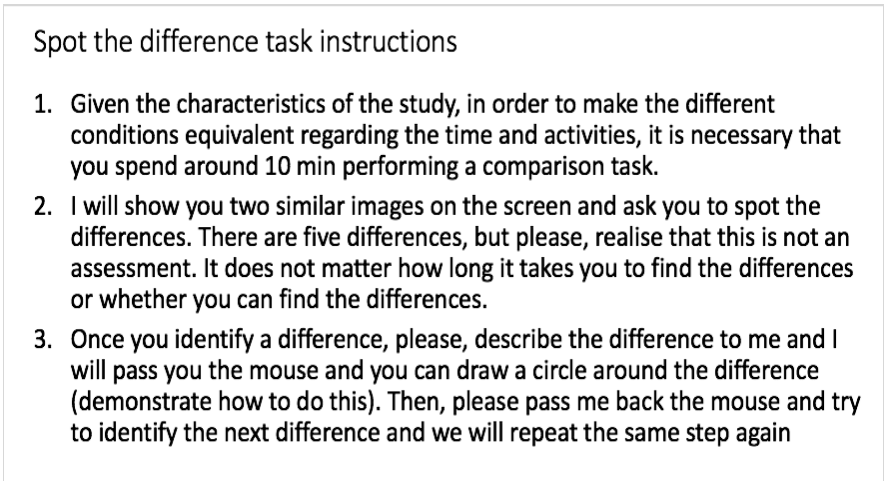

Figure 6 *Control condition "Spot the difference" task instructions.*

Each pair of images were displayed on a device screen in turn and participants were asked to identify and circle the differences (Fig. 7). Once a difference was identified the participants was handed the computer mouse and asked to circle the difference using the pen function. The process was repeated until all the differences were identified, or no further differences could be detected by the participants. At this point, the image with all the differences highlighted was shown to the participants (Fig.8). The same procedure was continued for all five pairs of images.

Figure 7 *Example of "spot the difference" task image.*
Note: Left-unaltered image, Right- altered image with five differences to the left image.

Figure 8 *Example "spot the difference" task image with correct answers*
Note: correct answers circled on the right-hand side image. Arrow points to the correct identification of missing clouds in the right-hand image.

The task was trialled to test for time of completion. On average the task was completed in around ten minutes, indicating both control and intervention delivery produced the same level of face to face contact with the researcher, avoiding bias of interaction time.

5.5.1.4 Stop smoking information material

After viewing the intervention or control task, participants were instructed to read a stop smoking information leaflet. The leaflet was used as a proxy to standard self-help smoking support offered online and through health providers. The leaflet contained literature from the NHS including methods for smoking cessation and the importance of social support, notably the leaflet was chosen due to the absence of appearance related information.

5.5.2 Stress assessment

5.5.2.1 Psychological stress

One of the aims of the research, was to assess the level of stress the intervention elicits in participants. Hence, level of subjective stress was measured, before and after the intervention session. Subjective stress was measured using a 5-point Likert scale (0 = *almost falling asleep* and 5 = *like something terrible is going to happen*). The measure was firstly introduced at pre-intervention and at the end of the session (after the information leaflet was given). Through the process of protocol development, in the RCT a further measure of subjective stress was introduced immediately after the intervention or control task delivery.

5.5.2.2 Physiological stress

Two measures of the physiological stress response were utilised within this thesis. The first is electrodermal activity (EDA), also known as galvanic skin response, which is defined as the change in electrical properties of the skin following stimulation. The other is photoplethysmography (PPG), used to estimate the skin blood flow utilising infrared light to capture heart rate (HR). Changes in blood volume are synchronous to an individual's heartbeat, meaning PPG can be used to determine HR (Saquib et al., 2015).

In both the pilot and RCT, electrodes were attached to the participants fingers (Fig. 9). Measurement of HR and EDA focused on specific time points within the research protocol. The first time point of data collection was a baseline at rest period in which participants were asked to focus on their breath and remain silent for two minutes. A measurement was first obtained at a time of rest, in order to have a baseline comparison to intervention delivery. Secondly, participants' measures of EDA Tonic levels (EDA Tonic), skin conductance response amplitude (EDA Amp) and HR were recorded throughout the intervention protocol capturing blocks of time for each Morph sequence. Additionally, in the RCT, measurements of EDA and HR were captured for each pair of images presented in the control, corresponding to each of the morphing intervention phases and named collectively as Phases -1-5.

5.5.2.2.1 Measurement of electrodermal activity

For measurement of EDA two disposable pre-gelled Ag/AgCl electrodes with 11 cm diameter contact, were placed on the volar surface of the middle phalanges of the index and ring fingers on the non-dominant hand (Fig. 9). A small direct constant voltage of 0.5 Volts direct current (vdc) was applied through one of the electrodes. When sweating occurs, e.g., in response to stress, the skin resistance to electrical voltage is reduced, creating a skin

conductance response (SCR) or EDA response. Electrode gel containing chloride salt (NaCL) was used on the surface of the electrode, to improve quality of the signal (Society for Psychophysiological Research Ad Hoc Committee on Electrodermal, 2012). In addition, in order to improve the quality of the recordings, electrodes filled with electrolyte gel were attached to the skin at least 10 minutes before recording took place, ensuring all participants have a reasonable degree of skin hydration (Braithwaite et al., 2013). Information regarding the skin conductance resistance was transferred from electrodes to signal amplifiers via transducers in order to filter and view the signal in form of a polygraph, with the microsiemens (μS) as the unit of measure.

5.5.2.2.2 Heart rate measurement

To measure HR, a PPG measurement device was used, which was later converted into the unit of beats per minute (BPM). The device consisted of an infrared light emitting diode and a phototransistor detector. The PPG device was secured to the volar surface of the middle phalange of the middle finger, of the participants non dominant hand (Fig. 9). The infrared device lights up the finger, some of this light is absorbed into the finger, some portion of the light is transmitted, and a small proportion of the light is reflected back to the device. The amount of light reflected varies with the volume of blood present in the fingertip, which indicates the rate of the heartbeat (Saquib et al., 2015). Lower intensity of light reflected back to the device indicates higher volume of blood, with higher intensity of reflected light indicating low volume of blood (Reisner et al., 2008).

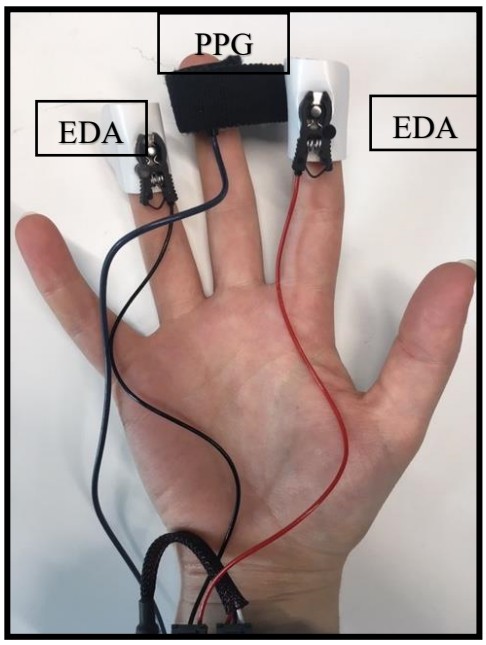

Figure 9 *Electrodermal activity and photoplethysmography electrode placement, on the non-dominant hand. Note: that the electrodes were placed on participants non-dominant hand*

5.5.2.2.3 Physiological measurement devices

The pilot study utilised the Biopac MP36, used to measure both EDA and PPG. The four channel device uses an exosomatic (DC) measurement of skin conductance. Each channel was set to 1000.000 samples/sec utilising a 24-bit A/D converter. Channels one (EDA) and two (PPG) were used during the pilot. The MP36 was software configured using AcqKnoweldge, with no hardware setting options.

For measurements of EDA the 11 mm contact Ag-AgCl disposable electrodes (Biopac EL507) filled with isotonic gel (0.5% saline in a neutral base, Biopac GEL101) connected to SS3LA transducer sending signal to the MP36 amplifier. For measurement of PPG the SS4LA photoplethysmogram transducer was placed on the middle finger and secured using Velcro tape, again connecting to the MP36 amplifier.

The SS10L pushbutton hand switch was used by the researcher to create manual markers during the intervention session. When pressed a +5 volt signal is created, when not pressed the button reads as 0 volts. Markers were placed at the start and end of the baseline and morphing sequences throughout intervention delivery.

Within the RCT the Biopac wearable device was chosen to enable mobility of the data collection. A BioNomadix logger records data from a dual-channel wearable device. The wireless PPG and EDA BioNomadix module pair device consisting of transmitter and receiver was used. PPG and EDA data was transmitted at a rate of 400Hz with raw data being bandlimited from DC to 10Hz.

As in the pilot, EDA was recorded with a pair of 11 mm contact Ag-AgCl disposable electrodes (Biopac EL507) filled with isotonic gel (0.5% saline in a neutral base, Biopac GEL101). The electrodes were connected to BioNomadix logger using the BN-EDA25-Lead2 attachment to connect electrodes with the wireless logger. For PPG the BioNomadix pulse transducer was attached to the same wireless logger as the EDA lead.

As in the pilot study markers were produced throughout the experiment using manual buttons on the wireless logger interface. Markers were placed at the start and end of the baseline and morphing sequences throughout intervention delivery.

5.5.2.2.4 Software data transformation.

AcqKnowledge (V 5.0) was used to analysed EDA and PPG data. For processing of the EDA signal for each individual data set was firstly visually inspected for artefacts, using the

connect endpoints feature to remove artefacts and spikes in the data when indicated within data collection notes. EDA data was then resampled to 125 samples a minute and filtered using a low pass FIR filter (Transform —> Digital filters -» FIR —> low pass, set to 2Hz). The RCT used an additional smoothing filter option Transform —> Digital filters -» Smoothing, —> median value, set to factor 5) to accommodate for the difference in data collection hardware. The phasic channel was derived from the EDA Tonic signal using analysis functions. Finally, all peaks higher than a 0.03 µS threshold were identified (Analyse—> EDA —> Find Peaks, upper at 0.03 µS, range of 0.01µS- 0.03µS with a rejection rate of 10%). All peaks identified in this way were considered Non-specific skin conductance responses (NS-SCRs). Mean EDA and NS-SCRs were calculated for the duration of the baseline and morphing/picture phases. Traditionally the threshold for identification of peaks has been set to 0.05µS, however recent research suggests that a threshold of 0.03µS closely approximates a SCR detection algorithm outlined by Kim et al. (2004) plus is more sensitive to changes in skin conductance, therefore it was considered appropriate for the current research. See Fig. 10 for a screenshot of the AcqKnowledge with an example of recorded data.

The PPG data was transformed into the unit of beats per minute (BPM), using the find cycles tool of Acknowledge software (Analyse—>Find cycle—>current peaks, output events as QRS peaks on the PPG channel). This tool allows the identification of QRS wave complex peaks in the data in addition to sky-scrappers and canyons in the signal. The connect endpoints feature was used again to remove artefacts and spikes in the data when indicated by the peaks and canyons that corresponded to data collection notes. A BPM channel was then calculated following the find peaks procedure, and the BPM was obtained for the baseline and morphing phases.

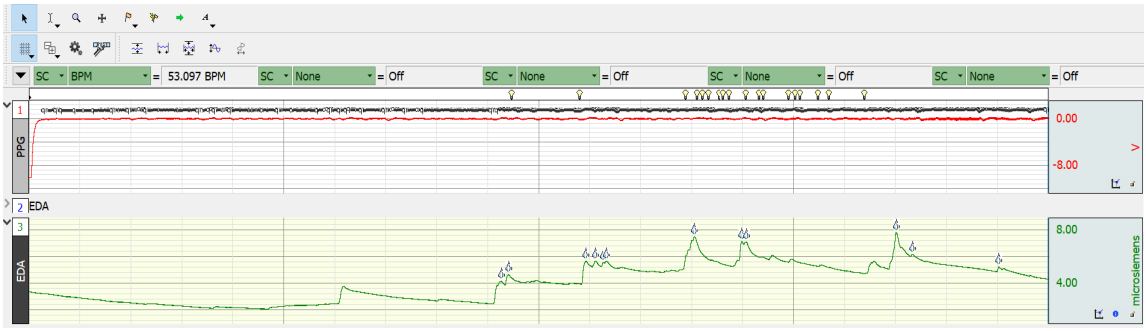

Figure 10 *Screen shot of the AcqKnowledge software, including representation of EDA and HR data. Note: light bulbs = manual markers, tear drops = skin conductance responses.*

5.5.3 CO breath measurement.

Smoking causes carbon monoxide to enter the circulation during smoking and forms carboxyhaemoglobin (COHb) which through respiration is expelled alongside CO from the body (Wald et al., 1981). CO breath has been used as an effective tool to assess smoking status (Deveci et al., 2004; Low et al., 2004; Pearce and Hayes, 2005) and smoking within 24 hours (Sandberg et al., 2011). The method has limitations in that it only captures CO inhaled within eight hours prior to measurement and therefore can easily be skewed by drops in smoking over a 24h period (Vasthare et al., 2018). Despite the limitations, recommendations indicate that different measures are needed to fully assess smoking behaviour including objective and self-report (Hughes et al., 2003). The current research utilised measurement of CO breath to provide an objective measure of smoking status confirming self-report smoking status on day of study session in both studies. The measure was the last to be obtained within the data collection session before partial debriefs were administered.

5.5.3.1 CO Measurement device.

A battery operated, portable carbon monoxide monitor was used [EC-50-Micro Smokealyser®, Bedfont Scientific, Limited, Kent, England]. The Bedfont EC-50 device has been shown to give reliable and valid assessments of smoking status (Grogan et al., 2011). A disposable cardboard tube was loaded into the device. Participants were instructed to take a deep breath and hold it in their lungs while the device counts down from fifteen seconds to zero. After that point a symbol appeared on the screen device indicating to expel the air. Participants were instructed to put their lips around the cardboard tube and expel all the air held in the lungs through the tube slowly until the lungs felt empty. The device measures the parts-per million (ppm) of CO in the lungs at that time, measuring in a range of 0-150ppm. An individual addicted to smoking is likely to produce a recording in the range of 10-36 ppm.

5.5.4 Questionnaires

A number of validated scales and questionnaires were employed to assess relevant factors for the research aims (smoking behaviour, stress response to the intervention, moderating and confounding variables). A questionnaire portfolio was created including all the self-report questionnaires and administered at pre-intervention (pre-) immediately post-intervention (post-), and at one- (1-), three- (3-) and six- (6-) months post-intervention (Table 4 at the end of measures section provides details as to when measures are introduced). Details and rationale for measurement inclusion are explained below.

Unless specified otherwise, all the materials in the sections below were collected in both, pilot and RCT; however, note that as the aim of pilot was to assess the feasibility of the procedure, only in RCT were all the measures included in the analyses.

5.5.4.1 Potentially confounding variables

5.5.4.1.1 Sociodemographic questionnaire

Sociodemographic variables such as age, ethnicity, employment and level of education, were included to understand the baseline characteristics of the study population. Measures were used to identify if biases in the results could emerge from differences within study populations. Note, items regarding ethnicity, employment, education were added to Block 2 of the pilot study and subsequent data collection after this point (note that corresponding ethical approval was granted).

5.5.4.1.2 Stress confounders.

A number of factors affect physiological stress response (Doberenz et al., 2011). The following steps were taken to monitor confounding factors and control for bias in the results. Short self-report questions were asked to account for factors affecting the physiological stress response. Age (Smith and Noble, 2014) has previously been identified to affect EDA recording, therefore participants were asked to report their age in the pre-intervention questionnaire. Results were checked for differences between age groups in the pilot investigation, while in the RCT, age was also controlled for through stratified randomisation procedure for participants below and above age 35. Menstrual cycle has also been indicated to affect levels of physiological stress (Gómez-Amor et al., 1990). Therefore, participants menstrual phase was estimated from the last date of menstruation and grouped into either the follicular (first 14 days), luteal (14 days onwards) or plus 28 days since last menstruation (Reed and Carr, 2000). Information regarding menstrual phase was also assessed in order to check whether the menstrual phases were distributed in a balanced way between all conditions within both studies.

Other items included food and drink consumption before testing, exercise before testing and use of prescribed medication. Medical conditions and medication are external factors that affect levels of EDA (Society for Psychophysiological Research Ad Hoc Committee on Electrodermal, 2012). Participants were asked to disclose the use of any medication intake within 24 hours prior to the experiment session and report on their health status. Information

obtained informed the decision to include or exclude participants from physiological data analysis if abnormalities in the data were observed consistently in the participant.

5.5.4.2 Potential moderating or mediating variables

5.5.4.2.1 Hospital Anxiety and Depression Scale

Levels of anxiety and depression affect smoking behaviour and adherence to smoking interventions (Borrelli et al., 1996; Kassel et al., 2003; Perez et al., 2008; Rose et al., 1983; Wiggert et al., 2016). Therefore, the Hospital Anxiety and Depression Scale (HADS) was included to assess the role of anxiety and depression (before and after intervention delivery) on smoking outcomes at each time point of longitudinal data collection, specifically in the RCT. The measure included 14 items (seven for depression, seven for anxiety). Each item is scored from 0 to 3, with a maximum score of 21 for each subscale (Zigmond and Snaith, 1983); scores between 0 to 7 are considered normal symptom levels, 8-10 probable clinical symptoms and > 11 equating to high levels of anxiety or depression symptoms depending on the subscale. In a review of 747 papers that used the scale internally consistency was indicated to be high, with on average .83 for the anxiety subscale and .82 for the depression subscale, therefore the scale was considered as a reliable measure of anxiety and depression symptom levels (Zigmond and Snaith, 1983; Bjelland et al., 2002).

5.5.4.2.2 Perceived Stress Scale

Perceived stress affects smoking behaviour through increasing urge to smoke (Chamik et al., 2017). The Perceived Stress Scale (PSS) is a psychological instrument used to measure a participant's perception of stress in their life (Cohen et al., 1994). The measure includes 10 items which asked participants to reflect on the last month before testing. Participants were asked to respond on a 4 points scale (0 = *Never*, 4 = *Very often*), scores on the PSS can range of 0 to 40. Items are designed to tap into how much participants feel their lives are unpredictable, uncontrollable and overloading in order to gain an overall picture of how participants appraise their lives during the previous month as stressful. The PSS was adopted in the study as it is one of the most widely used measure of perceived stress and has evidenced a high internal consistency (.86) (Cohen et al., 1983; Lee, 2012) and ability to predict failure to quit smoking (Cohen and Lichtenstein, 1990; Robles et al., 2016). The measure was introduced into the pilot at the start of Block 3 of data collection (corresponding ethical approval was granted) and was used throughout data collection in the RCT.

5.5.4.2.3 Multidimensional Body Self-relations Questionnaire (MBSRQ-AS) subscales Appearance evaluation/orientation.

Previous qualitative research of the intervention suggests that participants more concerned over their own appearance are more likely to respond positively to the intervention (Grogan et al., 2010b). Therefore, two subscales of the Multidimensional Body Self-relations Questionnaire (MBSRQ-AS), Appearance evaluation (in which higher scorers feel mostly positive about their appearance and Appearance orientation in which high scorers place more importance on how they look, were used. Scales were used to measure the extent to which an individual is concerned about their appearance, satisfied with their looks and the extent of their investment in appearance, in order to assess the moderating impact these dimensions had on the intervention outcome. Items were rated on a scale of one to five (1 = *definitely disagree* and 5 = *definitely agree*), the appearance evaluation scale consisted of 7 items with a maximum score of 35, while the appearance orientation consisted of 12 items with a maximum score of 60 (Cash, 2016). The MBSRQ-AS has been used successfully and extensively in health and body image research, with the subscales of interest within this thesis reaching an internal consistency of .88 and .85 when measured in women (Cash, 2016).

5.5.4.2.4 Weight Concern Scale.

Concern over gaining weight has been implicated in previous research as a major barrier to smoking cessation (Germeroth and Levine, 2018). The Weight Concern Scale [WCS; developed by Borrelli and Mermelstein (1998)] was included to understand the impact of WGC on the intervention efficacy. The scale includes six items investigating general and post smoking cessation weight concerns, and weight control. Items were rated on a scale of one to 10 (1 = *not at all* and 10 = *very much*), participants scores can range from 10-60. The scale has been shown to be internally consistent (.87) (Borrelli and Mermelstien, 1998) and has been utilised in various investigations to assess post- smoking cessation weight gain concern (Germeroth and Levine, 2018). The scale was incorporated into pilot at the start of Block 2 of data collection (corresponding ethical approval was granted), measurement of the scale was taken only at 6 months post-intervention to avoid priming participants with WGC during follow up periods.

5.5.4.2.5 The Fagerström Test for Nicotine Dependence

The Fagerström Test for Nicotine Dependence (FTND) assess the level of physical nicotine addiction (Heatherton et al., 1991). The FTND includes six-item scored and summed to create a score between 0 and 10. Higher scores indicate higher levels of dependence to nicotine. The measure has been reported as reliable, with an internal consistency of .64 (Pomerleau et al., 1994) and a valid screening tool (John et al., 2004) for nicotine dependence in a range of population samples, differing by geographical location (Huang et al., 2008; Stavem et al., 2008; Uysal et al., 2004; Vink et al., 2005; Lim et al., 2016).

5.5.4.2.6 Smoking Stage of Change.

The adult Stage of Change (short form) for smoking questionnaire includes three questions, with a series of options used to categorise individuals into the distinct stages of smoking change: non-smokers, pre-contemplation (smokers not seriously considering quitting), contemplation (smoker seriously considering quitting) and preparation (people who intend to quit), action (ex-smokers who have quit within that last six months) and maintenance (ex-smokers for six months or more). The stage of change questionnaire was developed by the University of Rhode Island Cancer Prevention Research Centre, based on the trans theoretical model of change, that depicts a series of stages that smokers move through as they successfully change their smoking habits (DiClemente et al., 1991). The measure was incorporated into the current research, as previous research suggests existing smoking interventions can be more successful if targeted during the preparation stage (Velicer et al., 1995). Due to the categorical nature of the questionnaire no internal consistency can be reported.

5.5.4.2.7 Quit smoking support

Participants were asked if they had engaged with any quit smoking support in the form of NHS online self-help, GP or stop smoking service. Information was gained to learn if participants had accessed support prior or post-intervention delivery to understand the impact of the intervention.

5.5.4.3 Smoking outcomes

5.5.4.3.1 Smoking behaviours

Smoking behaviour was recorded using a questionnaire developed by Grogan et al. (2010b). Participants reported the number of cigarettes they smoked on each day of the week previous to the session, and the total number of cigarettes for that week was calculated (*sum of*

cigarettes), participants responses are from zero upwards. As the intervention aimed to reduce smoking, at each time points of data collection, smoking behaviour during the previous week was assessed in order to evaluate long-term efficacy of the intervention.

Additionally, in the RCT two dichotomous variables were created to infer the effectiveness of the intervention conditions. Firstly, the presence of a quit attempt made between data collection time points was created from questions regarding if and when a quit attempt was made. The presence of a quit attempt was coded by a YES or NO depending on the participants response. Secondly, 7-day point abstinence from smoking the week before testing was created as a variable from participants responses to sum of cigarettes. If the number of cigarettes consumed equated to 0, then 7 day point abstinence was indicated to have been achieved and coded using YES. Alternatively, if the sum of cigarettes past week was above 0, then 7 day point abstinence was not indicted to have been achieved and coded as NO. Coding of abstinence was created for each follow up time point to display if relapse behaviour occurred at any point. Items were included upon recommendations for smoking cessation research in which minimum requirements for reports include information on sustained and 7 day smoking abstinence (Hughes et al., 2003).

Lastly information on smoking history (starting age of smoking) and the number of cigarettes smoked in the 24hrs prior to intervention session were implemented for the RCT investigation through protocol development (Chapter 6)

5.5.4.3.2 Smoking Cognitions

Smoking cognitions capture participants motivations and intentions to smoke and are considered a powerful indicator of behaviour change (Conner and Norman, 2005). Ajzen's theory of planned behaviour constructs has previously been used to predict a wide range of health behaviours (Conner and Sparks, 2005). Based on Ajzen's (1991) theory of planned behaviour constructs, Grogan et al. (2011) developed a 13 item questionnaire. Items were rated on a scale of one to 13 to gauge smoking cognitions. The Smoking Cognition questionnaire measures four constructs using four subscales: i) subjective norms (three items; e.g., *'People who are important to me would (disapprove–approve)*, *of me not smoking in the future'*) with a range of scores from 3-39 and a reported internal consistency of .60-.86 over three time points; ii) attitudes (four items; e.g., *'How would it be for you if you did not smoke in the future (harmful–beneficial*)') with a range of scores from 4-52 and a reported internal consistency of .80-.89 over three time points; iii) perceived behavioural

control (three items; e.g., *'I am confident that I could resist smoking in the future,(extremely unconfident-extremely confident*) with a range of scores from 3-39 and a reported internal consistency of .80-.87 over three time points; and iv) intentions (three items; e.g., *'I intend not to smoke in the future(strongly disagree–strongly agree*)') with a range of scores from 3-39 and a reported internal consistency of .78-.84 over three time points. The responses for each of the four constructs are averaged for each data collection time point. Smoking cognitions self-report measure was used as a dependent variable in order to asses if the intervention elicited changes in smoking motivations (Conner and Sparks, 2005).

Table 4 *Summary of measures used within the thesis (pilot and RCT) and time points of introduction.*

Measure	Section of data collection introduced	Measurement time point				
		pre-	post-	1-	3-	6-
Confounding measures						
Demographic questionnaire	B2	X				
Stress confounders	B1	X		X	X	X
Potential moderators or mediators						
Hospital Anxiety and Depression scale	B1	X		X	X	X
Perceived stress scale	B3	X		X	X	X
Appearance evaluation and orientation	B1	X				X
Stage of change	B1	X		X	X	X
Weight concern scale	B2					X
Stress measures						
Subjective stress Likert scale	B1	X	X RCT	X	X	X
Physiological stress	B1	X				
Smoking outcomes						
Smoking behaviour	B1*	X		X	X	X
Quit attempts	B1			X	X	X
Fagerström nicotine dependence	B1	X		X	X	X
Smoking cognitions	B1	X	X	X	X	X

*Note: B1 - Block 1 Pilot, B2 – Block 2 Pilot, B3 - Block 3 Pilot, RCT = randomised controlled trial. pre- = pre-intervention, post-= immediately post-intervention, 1-= one month post-intervention, 3- = three months post-intervention, 6- = six months post-intervention. * = Smoking 24hr prior to intervention session introduced at RCT.*

5.6 Participants

5.6.1 Participants eligibility criteria

Participants were eligible if they were women aged 18-55 years that self-identified as a smoker (smoking at least one cigarette a week) and had normal or corrected to normal vision. Participants were recruited only if were able to give full written consent and understand written and spoken English. Participants were asked to self- exclude themselves from taking part if they anticipated issues with the topics of body image and mental health.

The level of smoking behaviour required for the study was low in order to include in the study social and casual smokers [who are considered to be resistant to health focused public health attempts (Schane et al., 2010; Schane et al., 2009)]. In order to extend the age range of previous qualitative research that has focused on the examination of young to middle age smokers (18-35) (Grogan et al., 2010b) an upper age threshold of 55 was decided. Participants older than 55 could not be recruited due to the limitations of the age-progression software.

5.6.2 Recruitment strategies.

Participants were recruited through a range of strategies, including snowballing through existing contacts, research adverts and advertising via the Manchester Metropolitan University (MMU) participation pool (a university based research participation webpage for use by psychology students). The advert was placed in and around MMU campus and community notice boards, private pharmacies and university buildings in the central and south Manchester area. In addition, the advert was used in numerous recruitment stand events in and around university buildings (MMU). Lastly the study advert was circulated via existing contacts. For the RCT, the advert was also placed on a study recruitment webpage (University of Manchester). Interested participants contacted the researcher directly to arrange a test session, all contact details were stored appropriately according to the ethics application agreed storage plan.

5.6.3 Sample

5.6.3.1 Pilot

A minimum sample size of ten participants was recommended as optimal for pilot research in which clarity of instructions and/or ease of administration of measures is assessed (Hertzog, 2008). In line with this suggestion, the current research recruited thirty women in a block recruitment procedure of 10 participants in each block. Participants were block

randomised to receive one of the two intervention instruction types, meaning five participants in each block received the Neutral instructions and five the Reassuring instructions. Participants were recruited in blocks of ten, after which focus groups were conducted and protocol developments made (see Chapter 6).

5.6.3.1.1 Sample recruited pilot

The first ten participants making up Block 1 of the study were recruited and took part in the intervention sessions (including the individual interview), between the 18th of April and the 10th of May 2018. In the Block 2 participants took part in intervention sessions between the 14th of July to the 18th of August 2018. In Block 3, the last ten participants took part in the intervention sessions between the 15th of October and the 5th of November 2018.

Participants were recruited from MMU (n = 16) including staff (n = 3) and students (n = 13), and from the general public (n = 14), making a total sample of 30 women. Table 5 displays the frequency of participants recruited from each area across the blocks of recruitment.

Table 5 *Status of participant recruited to each block of the pilot*

Block	Student (n)	Staff (n)	General public (n)
1	5	1	4
2	2	1	7
3	10	0	0

Note: Block = phase of pilot.

After completing the intervention administration and the individual interviews, 10 participants also returned to take part in focus group discussions with participants from the same block of recruitment and instruction type. In total there were three Neutral instruction focus groups. Each focus group was conducted following the completion of the corresponding block of recruitment, before the start of the following block of recruitment commenced. The Block 1 and 2 Neutral focus group consisted of two participants, while Block 3 consisted of three participants. One Reassuring focus group was held after Block 1, including three participants.

5.6.3.2 Randomised controlled trial

5.6.3.2.1 Participant arms

Participants were randomised to receive one of three arms; either one of the two active intervention arms, which included: i) the age-progression intervention with the addition of

either Neutral or Reassuring instructions as described above ii) or the active Control arm in which participants engaged in a task of similar time and engagement as the intervention, but not related to smoking or appearance. Participants in all three arms received the stop smoking leaflet after the age-progression intervention or Control task delivery.

5.6.3.2.2 Randomisation procedure

Randomisation was achieved using SPSS (V25) (IBM, 2019), which was used to create a random list of numbers corresponding to one of the three arms. This random order was then checked to ensure each group had an equal number. The sequence was used to create manual files for data collection documents in which, depending on the arm, contained the corresponding protocol sheet, consent form and debrief documents. When a participant attended the data collection session the next available file of documents (and therefore corresponding condition) was used for the data collection session.

5.6.3.2.3 Stratification

Randomisation was stratified by age, splitting the sample into two groups, one for women 35 years and older, the other for women younger than 35. Previous research is focused on women under the age of 35, therefore, to ensure randomisation was equally spread for women over 35, stratification was implemented. Additionally, given that the age-progression intervention depended on the age of the participants, it was assumed that the aged morphed images would show more drastic effects within longer periods of ageing (e.g., participants 18 years old would be exposed to 54 years of ageing, while participants 55 years old would be exposed to a maximum of 17 years of ageing). To control for this potential effect, stratification by age was implemented in the RCT design.

5.6.3.2.4 Blinding

Within the current research, the researcher delivered and analysed data from all condition arms and therefore could not be blind to the research process. However, participants randomised into one of the two intervention arms were blinded as to the instruction type received, controlling for bias in terms of compliance and attendance to test sessions and follow up data collection within these arms. Fully blinding of the control condition was not possible due to the timing and nature of the task. The research therefore utilised a single blind design within intervention arms, with the acknowledgment that differences in task type and content between arms may have impacted on ability to fully blind participants to the control task.

5.6.3.2.5 Sample size calculation

The sample size needed for the RCT was based on results from previous similar research. In a previous RCT on an appearance-based intervention for women smokers (Grogan et al., 2011), thirty-five women were allocated to one of two conditions (control arm or intervention) with a reported effect size of d =.63 for nicotine dependence at 4 weeks post-intervention. Based on Grogan et al. (2011), to account for a 30% dropout at 6-months follow up fifty participants per group was required in the current study. Additionally, a priori power analysis has been conducted using GPower (Faul et al., 2007) which supports the specified number of participants per group. Specifically, to obtain a medium effect of .25 at a .80 power, a total sample of 158 was required (52 per group).

5.6.3.2.6 Sample recruited

The final sample size included 72 female participants, thus not reaching the threshold indicated by prior power calculation (discussed within chapter 10). The number of participants recruited reached just under half of the required sample. Participants were recruited and took part in face to face component of the research between the 14th of December 2018 and the 16th of October 2019, follow up questionnaire data was retrieved by the 27th of March 2020. Of the 72 women recruited n = 27 were randomised to the Neutral arm, n = 22 to the Reassuring and n = 23 to the Control arm. Participants were recruited from universities in Manchester (n = 54) including staff (n = 2) and students (n = 52), and from the general public (n = 18), making a total sample of 72 women. Table 6 displays the frequency of participants recruited from each area across the arms.

Table 6 *Status of participant recruited to each intervention arm of the RCT.*

Arm	Student (*n)*	Staff (*n)*	General public (*n)*
Control	18	0	5
Neutral	18	1	8
Reassuring	16	1	5

5.7 General procedure

Below is outlined the general procedure for both the pilot and RCT research. Procedures included both qualitative and quantitative data collection methods.

5.7.1 Pilot

The pilot procedure followed a three-part block recruitment procedure, in which ten participants were recruited to each block. The blocks comprised of five participants delivered the Neutral instruction and another five participants delivered the Reassuring instructions.

Potential participants who emailed the researcher expressing interest in the study were sent the participant information sheet. Once the participant agreed to take part in the research, an appointment was scheduled, and an email sent the day before to confirm participant's attendance. Participants were instructed to inform the researcher if they felt unwell or unable to attend the study appointment. Participants were scheduled to take part one of the three blocks of the pilot study, depending on time of recruitment.

The research intervention administration session (used for protocol development and quantitative pilot analysis) took place in a quiet room. Participants were welcomed to the room and asked to sit comfortably in a chair. In front of the participant was placed a computer device (a laptop in the pilot study) with the pre-intervention questionnaire loaded on to the screen. Participants were first asked to read again the participant information sheet and confirm they understood what the research entailed, and that they agreed to continue, after which the consent form was completed.

Participants were then asked which hand they would use to control the computer mouse throughout the research procedure. The opposite (non-dominant) hand was used to attach the electrodes for physiological measurements. In the pilot study the MP36 was switched on and the participants were asked to rest the hand (with the sensors attached) on their lap, palm facing up, in a comfortable position. The participants were asked to complete the first part of the portfolio questionnaires on the screen, which took on average ten minutes to complete. The researcher remained in the room to monitor the measurement of physiological values, the participant was allowed to move the device screen for privacy during questionnaire completion after which it was replaced to its original position facing both participant and researcher.

After completion of the questionnaire participants were instructed to close their eyes and focus on their breath for a two-minute baseline phase of recording. Afterwards, participants were displayed the intervention using the Neutral or Reassuring instructions, depending on allocation (allocation depending on study type). For the intervention, participants' facial

pictures were uploaded to the software and calibrated, and the intervention was delivered via five phases (Morph2D, Morph2D_R, Morph2D_R', Morph3D, Morph3D_R).

Immediately after the intervention delivery participants were asked to rate their subjective stress at that moment (introduced from Block 2 onwards; see Table 4 for details regarding time point of introduction of the questionnaires) and then given the stop smoking leaflet, which they were instructed to read through. Once read, participants were asked to complete a second questionnaire (post-) displayed on the device screen. Afterwards, physiological recording equipment was then removed from the participants, before CO breath measures were obtained.

For the protocol development and additional qualitative explorations, qualitative data collections methods of individual interviews and focus groups were employed, within the intervention administration session and at follow up time points. Directly after the CO breath measure, participants were asked if they were sitting comfortably and were read the information required for the interview component of the study. Participants responded to the interview questions, which was audio recorded. Participants were then given a partial debriefing after the intervention session and reminded that follow up questionnaires would be sent to the email address provided. Participants were then invited to return at a later date to take part in the focus group discussions with participants given the same instruction type, organised at the end of each block of recruitment. For the focus groups, participants were sent a selection of dates via email, in which they were instructed to select the best dates for focus group participation. The date which the largest number of participants could attend was selected for the focus group, details were sent out for participants to attend. For the protocol development, data from each block of recruitment were transcribed and analysed, for the implementation of the developments in the next block of recruitment. For the additional qualitative exploration analysis, data from interviews and focus groups were combined and analysed at the end of the third block of recruitment.

Following the study appointment, participants were sent an email thanking them for their participation with information regarding resources for smoking cessation support. Participants completed follow up questionnaire portfolios at 1-, 3- and 6-months post-intervention. For each of the follow-ups, two reminders with the date of completion were sent by email to the participants, the first reminder was sent seven days before date of completion and a second reminder was sent the day before the date of completion. The

questionnaire link was sent to participants on the due day to complete. If the participant failed to complete the questionnaire within a week, a third reminder email was sent asking the participants to complete the questionnaire as soon as possible. On completion of the final follow up questionnaire, a full debrief to the research was included. Information from questionnaire portfolios in the intervention session, as well as longitudinal time points and physiological measurements were combined at the end of the third block of data collection and analysed for the quantitative pilot investigation. Below, Fig 11. provides a visual representation of the pilot data collection timeline.

5.7.2 Randomised Controlled Trail

Participants were recruited continuously for the RCT. Following data collection from intervention sessions and longitudinal questionnaires, all data was combined for analysis.

As in the pilot investigation participants emailed the researcher expressing interest in the study, after which study information was shared and the intervention session was scheduled. On arrival to the test session participants were asked to self-report their age for stratification of participants above or below aged 35. After stratification participants were randomised to receive either the Neutral or Reassuring age-progression intervention or the Control intervention arm.

The intervention administration session again took place in a quiet room and followed the protocol set out for the pilot research, with the addition of protocol developments (additional questionnaire portfolio items and measurement of subjective stress). Instead of a laptop, a tablet was introduced within the RCT for the administration of questionnaire portfolios, age-progression intervention administration and Control intervention delivery (both, laptop and tablet had the same screen resolution and size). For the measurement of physiological stress, electrodes were placed on the participants non-dominant hand, which attached to the BioNomadix portable measurement device (introduced in place of the MP36 to allow for increased participant comfort).

After following the pre-intervention questionnaire delivery procedure set out in the pilot protocol, participants randomised to the age-progression intervention arms were administered the intervention via the five morphing phases with corresponding instruction type. Participants randomised to receive the Control intervention arm were shown and read

out task instructions on the screen and asked to complete the task set. The Control task displayed five pairs of images (Picture 1-5), equivalent in time to the morphing phases.

Participants were asked to rate their subjective stress immediately after the intervention arm delivery. Participants were then given the stop smoking leaflet and then asked to complete a second questionnaire (post-), displayed on the device screen. Physiological recording equipment was then removed, and CO breath measures were obtained before the partial debrief was administered.

Following the intervention administration session participants were sent emails containing information for stop smoking support. Post-intervention questionnaire portfolios were administered at 1-, 3-, and 6-months post-intervention, following the protocol for participant contact as outlined above. Fig. 12 provides a visual representation of the RCT data collection timeline.

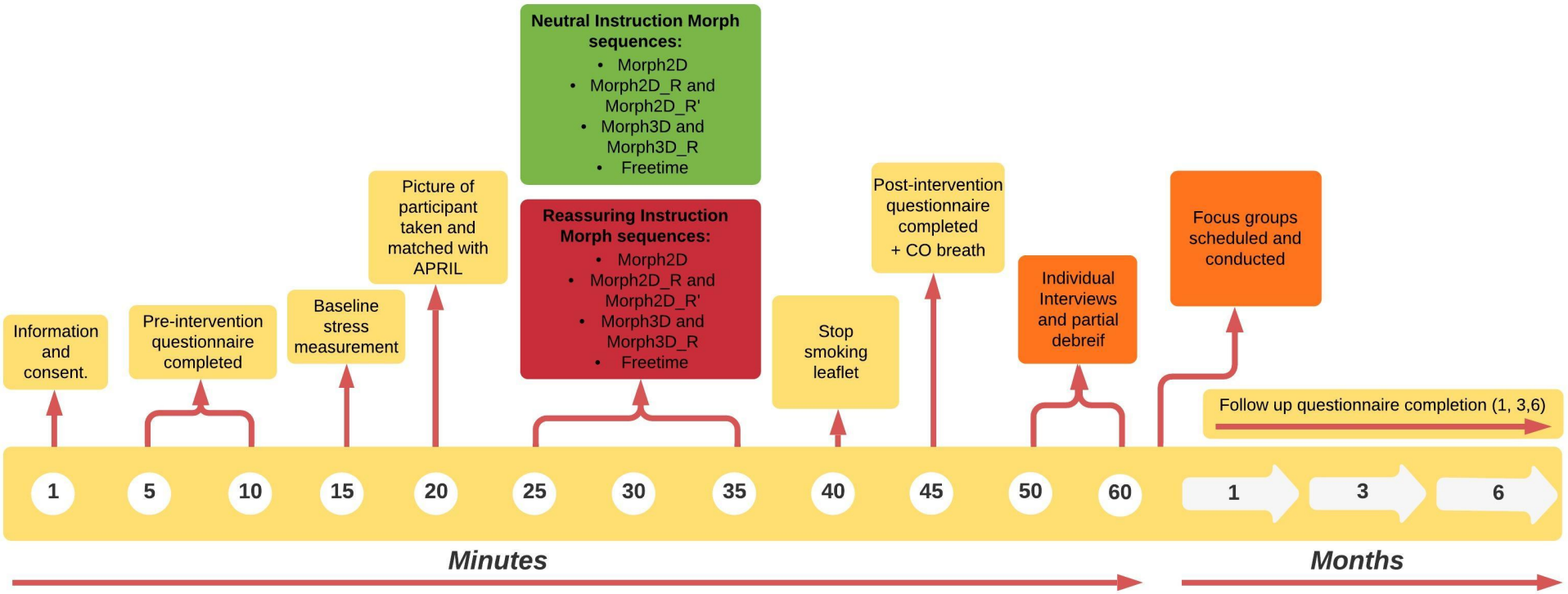

Figure 11 *Timeline of data collection in the pilot study.*
Note: Timeline displaying the pre-intervention and immediately post-intervention data collection procedure in minutes and longitudinal data collection continued after intervention session, including at 1-, 3- and 6- months post-intervention. Yellow = document and questionnaire completion, stress measurement and intervention set up, Green = Neutral instruction intervention delivery, Red = Reassuring instruction intervention delivery, Orange = qualitative data collection for protocol development and additional qualitative exploration analysis. APRIL: age-progression intervention, CO: carbon oxide measure. Morph sequences: Morph 2D (2D picture morphed at 72 years), Morph 2D_R and Morph 2D_R' (2D ageing morphing sequences), Morph 3D and Morph 3D_R (3D ageing morphing sequences, Freetime (participant led phase).

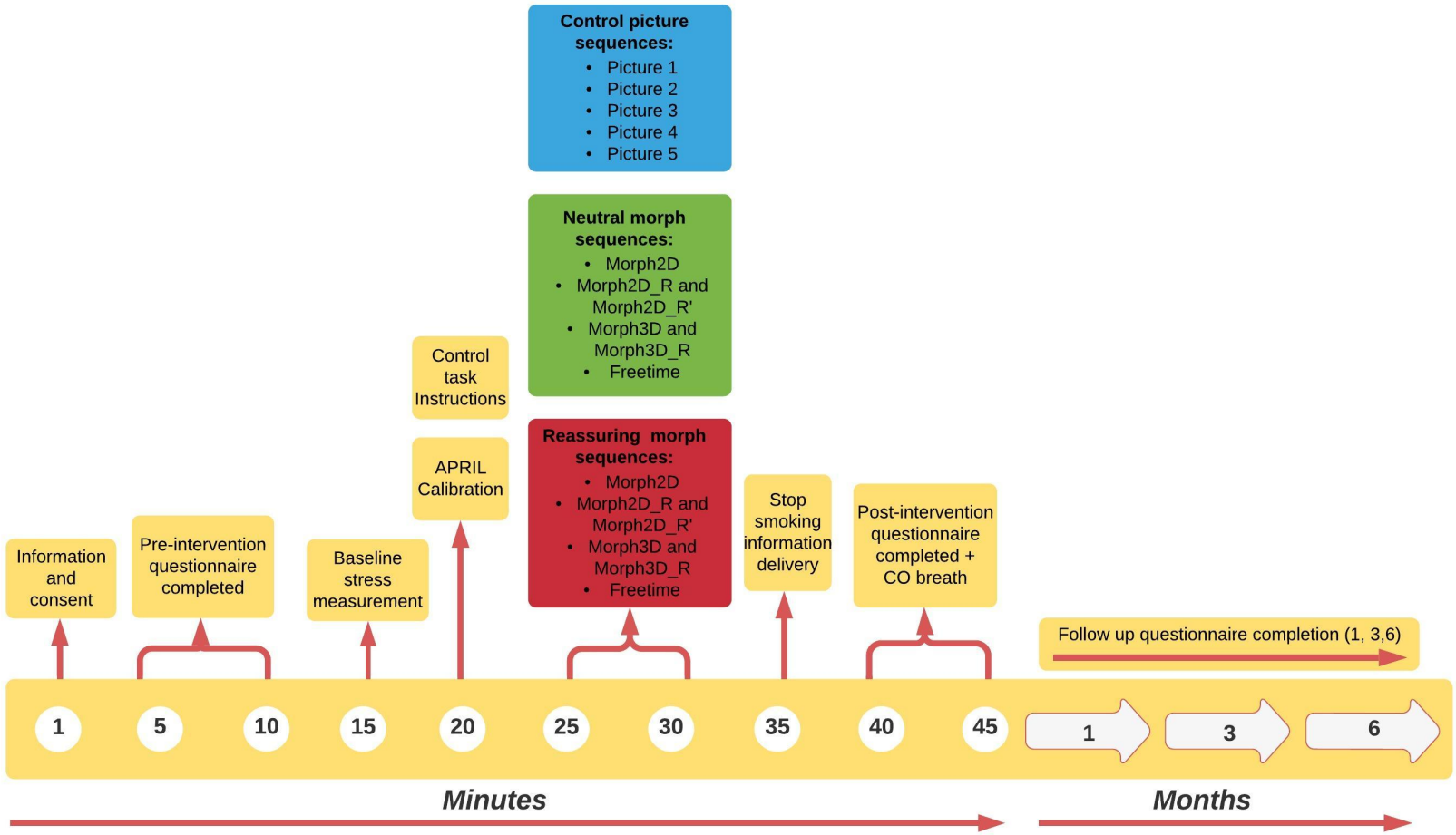

Figure 12 *Timeline of data collection for the RCT.*
Note: Timeline displaying the pre-intervention and immediately post-intervention data collection procedure in minutes and longitudinal data collection continued after intervention session, including at 1-, 3- and 6- months post. Yellow= document and questionnaire completion, stress measurement and intervention setup, Green = Neutral instruction intervention delivery, Red = Reassuring instruction intervention delivery, Blue = control arm delivery. APRIL: age-progression intervention, CO: carbon oxide measure. Morph sequences: Morph 2D (2D picture morphed at 72 years), Morph 2D_R and Morph 2D_R' (2D ageing morphing sequences), Morph 3D and Morph 3D_R (3D ageing morphing sequences, Freetime (participant led phase).

5.8 Data analysis

5.8.1 Qualitative

5.8.1.1 General analysis approach

Thematic analysis was used to analyse individual interviews and focus groups from the protocol development and additional qualitative exploration of the pilot study. Thematic analysis is a commonly used method in Psychology, and the method aids the identification, analysis and reporting of patterns from the data and can be applied to a variety of research areas (Braun and Clarke, 2006). The approach was chosen due to the applicability of the analysis method to a range of theoretical positions (Nowell et al., 2017). Furthermore, the analytic approach is considered an effective method of identifying, in a rich and comprehensive manner, not only similarities but also differences in the way that the participants experienced the age-progression intervention and research protocol (Braun and Clarke, 2006).

Six key steps were planned and followed with regards to analysing focus groups and individual interviews, as suggested by Braun and Clarke (2006). Step 1 consisted of familiarising with the data, including transcribing, reading and re-reading transcripts and logging initial thoughts regarding the content. Next, step 2, included coding all transcripts in a systematic way, looking specifically for interesting features of the data. Step 3 consisted of grouping the codes previously created into themes or subthemes. Step 4 involved checking whether the quotes extracted tie to the theme and generating a thematic map to explore how each theme relates to each other. Step 5 involved generating names and clear definitions for each of the themes (unless theme names were pre-defined), ensuring the themes are refined and specific. Lastly, step 6 included the selection of compelling quotes that best represent each theme and subtheme and relating these quotes back to the research question and literature in the form of a qualitative report.

Qualitative data analyses were facilitated, using NVivo Qualitative Data Analysis Software v11 (Nvivo, 2015). NVivo software allowed emerging themes to be structured in a clearly organised manner, promoting rigour and transparency in the analysis process (Houghton et al., 2017).

5.8.1.2 Protocol development analysis

Thematic analysis steps as described above were applied to data obtained from both instruction types in individual interviews and focus groups of the pilot study. Data were

analysed in combination at the end of each block of recruitment and data collection. Patterns in the data, commonly named themes were identified in a-priori 'top down' way (Braun and Clarke, 2006). Areas of the interview guide developed to understand the research protocol (Intervention delivery, Questionnaire content/delivery and Physiological measurement), were identified as topics of interest and named as the themes. Participants responses to these areas of interest were analysed, to identify subthemes within the data. Subthemes were evaluated by the researcher, with suitable identified suggestions for protocol development applied to the next block of recruitment. The cycle of thematic analysis continued for all three blocks of the pilot data collection.

5.8.1.3 Additional qualitative exploration analysis

The general analysis approach outlined above applied to the additional qualitative investigation of women's experiences of the age-progression intervention. Specific to this exploration, data from the individual interviews and focus groups were combined at the end of the third block of pilot data collection and analysed using inductive thematic analysis ('bottom up'). The inductive approach was chosen in order for the themes to be strongly linked to the data and not to be pre-determined by the researchers existing preconceptions, allowing unexpected themes to be identified within the data (Braun and Clarke, 2006). During the process of inductive thematic analysis, themes were developed initially by the researcher following guidelines for thematic analysis. The list of themes and related quotes were then checked by the second supervisor and advisor, who have extensive experience in qualitative analysis within the subject area. Through this process, each theme was further discussed regarding how it fitted and connected to other themes. Where members of the team disagreed, a discussion was held. If agreement was still not met the researcher had the final decision over inclusion of the theme, theme heading and sub-heading names. Discussion in this way facilitated thorough qualitative analysis (Whittemore et al., 2001), increasing validity of (Smith, 2015) and trustworthiness of findings (Nowell et al., 2017).

Comparisons were made between instruction type, by assessing how themes were populated by participants from the two instructions (Lindsay, 2019). This analysis allowed for interpretation of differences in experience between the Neutral and Reassuring instructions. Comparison within qualitative data was performed following recommendations for qualitative comparison in health research (Lindsay, 2019). Lindsay (2019) suggests that using comparison within a qualitative setting helps to highlight gaps in understanding and challenge assumptions made from previous research.

5.8.2 Quantitative analysis

A range of quantitative data analysis techniques are implemented for the pilot and RCT research. In both studies descriptive data from all variables is presented as means and standard deviation (M and SD) or median and range (Mdn and Rng), depending on normality of data and statistical tests used.

5.8.2.1 Pilot

5.8.2.1.1 Stress response analysis

Mean amplitude (EDA Amp) of skin conductance responses, EDA mean tonic level (EDA Tonic) and HR were inputted as raw variables for baseline and morphing phases. Additionally, the percentage of change from baseline to each morphing phase was calculated for EDA and HR average. All physiological variables were inputted into either a repeated measures ANOVA with post hoc comparisons for parametric data, or Freidman's test with post hoc comparisons for non-parametric data, to assess whether stress increased from baseline to each Morph phase.

Due to the pilot nature of the study, exploratory analyses regarding group differences of the stress response during the intervention were performed. Results were used to inform the RCT study design and decision to include instruction types and procedures (Chapter 9).

Subjective stress measures were obtained pre-intervention (pre-) and post-intervention (post-). A Wilcoxon test of difference was employed to assess if there was a significant difference between these two time points. Between subjects test Man Whitney-U was used to assess differences in instruction types at both pre- and post-intervention time points.

5.8.2.1.2 Smoking outcome and smoking cognition analysis

The smoking behavioural outcomes included the sum of cigarettes consumed during the 7-days prior to testing across all follow up time points. These measures were included as raw scores (number of cigarettes consumed in the week prior to testing) as well as the calculated percentage change from pre-intervention to each follow up time point (1-, 3- and 6- months post-intervention). Additionally, information regarding the sum of cigarettes consumed the week prior to testing was used to inform coding of 7 day point abstinence. If a total of 0 cigarettes was recorded, this was coded as 7 day point abstinence. Participants also reported if they had made a quit attempt within the time between last testing coded as a binary YES or NO response.

Smoking cognitions included the following subscales; attitudes, intentions, perceived behavioural control (PBC) and subjective norms (SN). Smoking cognitions were self-reported on a scale of 0-13 and scores averaged. Higher scores on subscales intentions, attitudes and PBC, and lower scores of subjective norms, equated to more positive cognitions towards smoking cessation. Smoking cognitions scores were obtained at all data collection points (pre-, post-, 1, 3 and 6). The percentage change of each subscale was calculated from pre-intervention (pre-) to each follow up time point (post-, 1, 3 and 6). This was achieved by calculating the difference between the two time points (for example pre-intervention and 1-month), dividing the difference by the pre-intervention time point measure and finally multiplying the figure by 100 to create the percentage of change.

Number of cigarettes consumed, and smoking cognitions were analysed using both analysis of variance (ANOVA) with post hoc comparisons or Freidman's test with post hoc comparisons dependent on data normality. Instruction type was entered as a between subjects' factor in order to assess group differences at each time point. Chi-square analyses were used in order to test whether the distribution of binary outcomes of 7 day point abstinence and quit attempts differed between instruction types.

5.8.2.2 Randomised controlled trial

All analyses were conducted using SPSS v.26 (IBM, 2019). For all scales, Cronbach's alpha was calculated at baseline and for each of the follow up time points to determine the internal consistency of the scale at each time point of data collection within the current sample. Cronbach's alpha (Cronbach, 1951) is widely used to measure internal consistency within social sciences, it describes the reliability of the sum or average of a questionnaire or scale (Bonett and Wright, 2015). It is generally agreed that a Cronbach alpha threshold of .70 indicates an adequate level of internal consistency.

5.8.2.2.1 Intent to treat analysis and handling of missing data

Analysis of the primary and secondary outcome measures followed mostly intent to treat method, in which all participants are included in the group in which they were randomised into irrespective of compliance to follow up (Gupta, 2011). Intent to treat avoids bias of dropout across groups (Armijo-Olivo et al., 2009). In order to complete the intent to treat analysis, a method of data imputation was employed to deal with missing data from attrition. The maximum likelihood method of missing data imputation was chosen over other methods, due to its ability to handle interaction based analysis (Allison, 2012; Jakobsen et al., 2017). Expectation-maximisation algorithms were applied in SPSS to find the maximum

likelihood estimates, through firstly estimating the values for missing variables and then optimising the model, to best explain the data before converging the two (Enders and Bandalos, 2001). Before imputation, the Little's test and Chi square tests were used to assess if the data was missing at random. If data did not meet requirements of missing at random (MAR) or missing at complete random (MACR), imputation could not be produced. Additionally, if missing data reached more than 40% of cases then imputation could not be conducted (Jakobsen et al., 2017). Non intent to treat analysis were also conducted to assess if results differed between analysis methods, results of which can be found in Appendix 5.

5.8.2.2.2 Outcome analysis

The effectiveness of the age-progression intervention arms (independent variables; IVs) at each data collection time point (immediately post-intervention, and 1-, 3- and 6- months post-intervention) on the primary (Intentions) and continuous secondary (Attitudes, PBC, SN, sum of cigarettes) outcome measures was examined using analysis of covariance (ANCOVA), controlling for respective baseline measures. ANCOVA is suggested to be an effective method of analysis for use in RCT's, as it effectively models changes in scores (O'Connell et al., 2017) and provides the best estimation for analysing continuous outcomes (Zhang et al., 2014). For binary secondary outcome variables (quit attempts and 7 day point abstinence), Chi square tests were conducted at each follow up time period of data collection assessing for differences in the IV groups.

5.8.2.2.3 Stress analysis

Similarly, as indicated above for the analyses of stress in the pilot study, within this study the level of stress was assessed for differences between arms including two instruction and control arms, over points of data collection (morph phases and pictures). The effect of the intervention arms on levels of subjective stress was assessed using both i) one way ANOVA at pre-, after intervention delivery, and after administration of the stop smoking leaflet and ii) repeated measures ANOVA of percentage change of levels of stress from baseline (with a repeated measure factor of time of measurement) included to control for baseline differences between arms. Assessment of the effect of the IV on measures of physiological stress (EDA tonic, EDA amp, HR) was analysed using repeated measures ANOVA of the percentage change from baseline with a repeated measures factor of Morphing phase (Morph2D, Morph2D_R, Morph2D_R', Morph3D and Morph3D_R) and Arms as the between subjects factor.

5.8.2.2.4 Additional analysis

Additional exploratory analyses were undertaken in addition to the primary, secondary and stress outcome analysis, to explore the impact of potential confounding variables on the efficacy of the intervention. Exploratory analysis included both mediation and moderation analysis utilising the Process macro V3.4 developed by Hayes (2017). Mediation analysis was conducted using the Hayes Process macro (Hayes, 2017). The approach is widely used within health research as it allows the estimation of direct and indirect effects within models. Instead of simplifying the research groups (presentation of only two groups) as previously used in a range of research (Hayes and Montoya, 2017), a multi-categorical approach was implemented in the context of intervention research (Baron and Kenny, 1986). The Hayes approach therefore allowed for each intervention group to be investigated as the predictor variable and represented within the chosen model, allowing for effective interpretation of the results (Hayes and Montoya, 2017).

The stress variables (EDA Tonic, EDA Amp, HR and subjective stress), were entered into statistical models as both mediators and moderators. Other potentially confounding variables (Anxiety, Depression, PSS, Appearance evaluation, Appearance orientation, WGC), were entered into moderation models only. Smoking outcome variables found to significantly change, dependant on the effect of intervention arm, were entered into the moderation and mediation analysis as the outcome variable.

Mediation models were calculated to infer if the effect of the predictor variable (intervention arm) on the smoking outcome, was mediated by a third variable (measure of stress). For mediation models, the direct effect of the predictor (intervention arm) and mediator (stress measure) on the smoking outcome was interpreted, as well as the indirect interaction effect between the mediator and the predictor, on the outcome variable.

Moderation models were conducted to infer the specific conditions under which the predictor of intervention arm related to the smoking outcome. The effect of the predictor on the smoking outcome is assessed at different values of the moderator (stress or confounding measure).

5.9 Ethical considerations.

Prior to data collection ethical approval was granted by the MMU Health, Psychology and Social Care Faculty Ethics Board. The British Psychological Society (BPS, 2019) ethical guidelines were adhered to and incorporated into research practice.

Participants were asked to create a unique participant code at the start of the research, used to identify the data to preserve anonymity. Procedures in place ensured data remained anonymous and protected throughout data collection and storage. A potential ethical issue of this research was whether the intervention being appearance based in nature, drew women's attention to appearance and unrealistic body image standards, found to promote body dissatisfaction (Grabe et al., 2008; Izydorczyk and Sitnik-Warchulska, 2018). However, the intervention has previously been implemented into a range of research and health settings, not found to create discomfort to this effect (Flett et al., 2013; Burford et al., 2013). Previous research also clarifies how the intervention displays the realistic ageing effects to the skin, with and without the effect of cigarette smoke. In doing so, the intervention does not perpetuate unrealistic beauty standards, it instead aims to promote autonomy of smokers to make decisions that will affect the way their skin ages (Grogan, 2012a). In previous qualitative explorations of the intervention in the context of sun damage, women related positively to the non-smoking aged images (Persson et al., 2018a). These findings indicate that the intervention could promote positive acceptance of natural ageing, rather than body dissatisfaction. Therefore, the intervention was determined as not unethical in its application.

No negative reaction was expected from participants after exposure to the intervention image based on previous work using physiological measures (pilot study) and the APRIL age software (Grogan et al., 2011). However, to counter the possibility of an adverse reaction, counselling support, GP and researchers' contact details were provided to all participants after the intervention and control session. Participants were also informed they had the right to withdraw at any point during the study appointment and remove their data from the study up to dates stipulated on the information sheets, after the session and follow up questionnaires were complete. Given this information no participants expressed a wish to withdraw their data at any point during data collection and no informal or formal complaints were registered regarding the research.

5.10 Chapter summary

The chapter presents details and justification for all aspects of the methodology included within this thesis. The mixed method approach woven throughout this thesis is justified and related to all aspects of study design. In addition, the quantitative and qualitative aspects are depicted in detail with rationale provided for every aspect. For individual studies measures, participants, procedure and analysis are presented. All sections of this chapter provide the

foundation for later chapters and is therefore a key aspect to the thesis. In Chapters 6, 7, 8 and 9 reference will be made to pertinent sections of Chapter 5 when necessary.

6 Chapter 6: Protocol development

6.1 Introduction

The pilot study included both qualitative and quantitative data collection methods, named collectively as the pilot study. Details regarding the mixed methods approach used can be found in Chapter 5, while qualitative data collected from the pilot is presented in this chapter. Qualitative research was conducted as part of the pilot investigation to assess the participant perceptions of the research protocol and assess how the protocol could be improved and developed to be implemented in the RCT study (Chapter 9). The pilot investigation used a block recruitment design to enable individual interviews and focus groups to be transcribed, analysed and protocol changes implemented in between each block of recruitment. An additional component of qualitative investigation was to explore the experiences of participants who received the age-progression intervention, which is presented later in Chapter 7. The qualitative aspect of the pilot investigation therefore presents information from the block recruitment protocol, outlining the development of the research protocol through qualitative exploration of individual participant responses and group discussions.

6.2 Methodology

Details regarding the research design, data collection, transcription and analysis of the qualitative responses was outlined in Chapter 5 methodology (sections 5.4 and 5.8.1). The results and discussion for this part of the pilot study, the qualitative protocol development are outlined below.

6.2.1 Participant information

Thirty participants took part in the study. The sample consisted mainly of white females (n = 28) with the exception of three Asian participants, with ages ranging from 18-54 years (M = 28.2 years, SD = 9.7). All participants identified as smokers and volunteered to take part. All the participants took part in individual interviews (performed immediately post-intervention), ten participants also returned to take part in four individual focus group discussions details of which can be found in Chapter 5. Table 7 (Neutral instruction) and 8 (Reassuring instruction) provide details of participant age, smoking behaviour, block of recruitment and ethnicity for each instruction type. Pseudonyms are used (outlined in Tables 7 and 8) which are referred to throughout this chapter to protect the anonymity of participants.

Table 7 *Information of participants block randomised to the Neutral instruction type of the pilot study.*

Block	Pseudonym	Age in years	Cigarettes per day	Ethnicity
1	Charlotte	22	1-5	White European
	Naomi	23	1-5	Asian
	Grace	22	1-5	White British
	Anna	21	1-5	Asian
	Laura	39	16-20	White British
2	Zara	43	6-10	Unknown
	Suzy	34	6-10	White European
	Ella	22	6-10	White British
	Elaine	48	11-15	White British
	Claire	52	16-20	White British
3	Candice	22	1-5	White British
	Mary	25	1-5	White British
	Simone	24	1-5	White British
	Jody	19	11-15	White British
	Sarah	20	1-5	White European

Note: Block = phase of recruitment during pilot.

Table 8 *Information of participants block randomised to the Reassuring instruction type of the pilot study.*

Block	Pseudonym	Age in years	Cigarettes per day	Ethnicity
1	Jane	32	1-5	White British
	Becky	22	6-10	White British
	Tabitha	25	11-15	White European
	Chelsea	25	6-10	Asian
	Bridget	23	1-5	White British
2	Kelly	22	6-10	White British
	Sally	34	6-10	White British
	Frankie	25	21-25	White British
	Hannah	20	1-5	White British
	Leslie	25	6-10	White British
3	Amy	23	1-5	White British
	Alex	24	6-10	White British
	Veronica	54	16-20	White British
	Eve	28	11-15	White British
	Leanne	24	16-20	White British

Note: Block = phase of recruitment during pilot.

6.3 Analysis

Data was transcribed verbatim using transcription conventions outlined in Chapter 5. Data was analysed using thematic analysis, in which both top down and bottom up approaches were implemented, as questions framed the responses gathered. Four themes were pre-selected for each block of recruitment, while numbers of sub themes varied depending on the block of analysis. Transcription and analysis of the qualitative responses is described in more detail within Chapter 5 (Sections 5.8.1).

6.4 Results

Results are separated by block of recruitment, in which pre-identified themes, including: Intervention delivery, Questionnaire content/delivery and Physiological stress measurement are outlined. Within each theme, sub themes have been identified from participant responses and are outlined with support from illustrative quotes. At the end of each block details of the researcher assessment is outlined including observations from the block of recruitment and details of additional protocol developments made.

Illustrative quotes are outlined below in order to describe the protocol development and additional results. All quotes are verbatim; only inaudible speech has been removed. Numbers in round brackets indicate the length of pauses within seconds e.g. (2), pauses less than a second are indicated by (.). Square brackets indicate additional information where needed. Pseudonyms have been assigned to each participant and will appear within square brackets at the end of quotes. If the participants received the Neutral instructions this will be indicated by N the Reassuring by R.

6.4.1 Block 1.

1) Intervention delivery:

a. Fast delivery of images

Participants within the first block felt as though the intervention displayed the ageing process quickly, resulting in the participant not having enough time to appreciate the changes between the smoking and non-smoking age-progressions. For instance;

> ‘erm maybe you know when you show them both as a progression maybe stopping at certain intervals because it’s hard to look at both at the same time, so if you stopped it at like forty fifty sixty then ye you would get a sense of how fast it happens’ [Jane, R]

Three out of ten participants mentioned that the images morphed at a fast pace, reducing their capacity to notice the differences between the two images. This aspect of the protocol was important to develop, as being able to view and appreciate the differences between the aged images is crucial to the efficacy of the intervention. To solve this issue, extra time was added at the end of the intervention in the form of a final participant led morphing phase (‘Freetime’), which was implemented within Block 2 of pilot data collection. During this extra time, participants were encouraged to explore the differences between the smoking and non-smoking images at different ages of the morphing sequence. This was achieved by

altering the age of the morphing sequence using the slide bar tool provided by the software, placed at the bottom of the screen (see Fig. 4). The addition of the "Freetime" phase allowed participants to return and review ages of interest, in order to appreciate the differences in their skin made evident between the smoking and non-smoking images. After the development in protocol was introduced, the theme did not appear in participant responses in later Blocks (2 and 3).

2) *Questionnaire content/delivery:*

a. Context for questions regarding personal information.

Within Block 1, participants suggested that providing more information regarding the reason why personal information such as, medication use, and the date of the last menstrual cycle was needed within the questionnaire, would help to develop the protocol. Participants stated that they were uncertain about how this type of questions were related to the study, indicating they needed more clarification as to why the questions were included, in order to feel comfortable answering them.

> 'I would say there were ones about medication you are taking and I think for me that made me feel quite uncomfortable I'm not really sure how that linked (.) ye I was just a bit confused.' [Bridget, R]

Two out of ten participants' responses were present within this theme. Due to the sensitive nature of the questions, and the potential of negatively impacting on the participants, the protocol development of communicating the reasons requiring personal sensitive information was introduced. The information was provided to the participants before the introduction of potentially sensitive items of the questionnaire. In addition, participants were reminded of their right to withdraw, the voluntary nature of participating in the study and that the responses provided remained anonymous. After the introduction of this protocol development, the theme did not appear in transcripts from Block 2 and 3. This suggests that comforting the participants as to the reason for gathering personal information that can impact the research may mitigate concerns about disclosing sensitive information.

b. Additional demographic questions

Another suggestion that arose from participants for protocol development was the need for demographic information to be gained from questionnaires. One of the ten participants in Block 1 stated that they were surprised limited demographic questions were included in the pre-intervention questionnaire (questions regarding nationality and smoking history not included prior to Bock 1), and stated that if questions regarding more detail of participant

demographics were included it would provide context of her own smoking behaviour due to information regarding cultural norms. For example;

> 'so ye sure so I'm French so it's like really hard in France not to smoke because literally everyone around me smokes so umm umm ye so that explains why I am smoking' [Anne, N]

Although only suggested by one participant, the inclusion of demographic information such as nationality, level of education and work status could all play a role in smoking cessation and relapse and therefore be an effective development to the questionnaire and protocol. From Block 2 and 3 questions such as 'What nationality do you identify as?' were introduced into the pre-intervention questionnaire. Given the nature of the pilot study and the small sample size recruited within the university, the demographic information such as education was not included initially. However, after the participant comment, the inclusion of the SES data in the pilot study was discussed and agreed by the supervisory team.

3) Physiological measurement:

Regarding physiological measurements used during the intervention sessions, participants were asked to comment on how they felt about the electrodes being attached and if they felt distracted by them during the intervention.

a. Impartial reaction to the electrode placement

All ten participants within Block 1 stated no problems with the electrode attachment. Participants accepted the electrodes without raising any concerns that was completely fine ye' [Grace, N]. Three of the ten participants stated they forgot the electrodes were attached, 'No (.) I forgot they were there to be honest with you' [Jane, R]. This indicated that the physiological devices used in the intervention posed no threat in distracting participants from viewing the intervention image, and that they felt comfortable to sit with them attached for the duration of the 45-minute session.

4) Researcher assessment:

At the end of data collection of Block 1, notes and insights from the researcher regarding the protocol and general procedure were discussed with the supervisory team. Two further changes to the protocol were implemented; the addition of a measure of subjective stress immediately post-intervention, and the inclusion of a scale to measure weight gain concerns (WGC).

When the protocol for the pilot study was initially designed, measurements of subjective stress were obtained at two time points, pre-intervention and after the delivery of stop smoking information. At the end of Block 1, the decision was made to include another measure of subjective stress, added directly after intervention delivery. This measurement of subjective stress immediately after the intervention was incorporated to capture the level of stress induced by the age-progression images used in the intervention.

Additionally, a scale to measure post-cessation WGC was introduced in the protocol at this stage of protocol development (Borrelli and Mermelstein, 1998). As reviewed in Chapter 2, WGC can act as a barrier to smoking cessation (Germeroth and Levine, 2018). While the relevance of assessing competing barriers to quit smoking was acknowledged, concerns with regards to priming of WGC was also considered. A final decision was made to implement the scale at the final follow up questionnaire (at 6-months post-intervention), in order to minimise the risk of interfering with the outcome of the intervention.

6.4.2 Block 2.

1) Intervention delivery:

a. Printed photograph of intervention image

Two of the ten participants in Block 2 suggested the images produced by the intervention software should be printed and given to the participant to view at a later date. For example;

> 'um I think maybe printing off the photo, printing off the photo would be really good ummm' [Leslie, R]

Previous appearance-related intervention research Grogan et al. (2011b) has suggested that providing participants with the image may lead to habituation to the intervention image, rendering it ineffective in changing smoking behaviour (Rankin et al., 2009). Therefore, this suggestion was not adopted into a protocol change.

2) Questionnaire content/delivery:

a. Option to increase font size

One suggestion that was identified in the questionnaire during Block 2, was the option to increase the font size of the online window for the questionnaire. One of the ten participants noted that the questionnaire font size was small, and they would have preferred a larger font.

> 'Umm slightly bigger writing because I think I have good eyesight but I had to lean in because it tiny' [Sally, R]

Therefore, participants from Block 3 onwards were asked if they could clearly read the text on the screen of the pre-intervention questionnaire and if needed adjustments were made to the font size. Although the suggestion was made by only one participant, the decision was made to implement the protocol improvement as to minimise the influence the participants perception had on the attention paid to the questionnaires and intervention content. This suggestion did not appear in later blocks of the study, indicating the protocol improvement may have been effective.

3) Physiological measurement:

a. Impartial reaction to the electrode placement

Overall, during Block 2, participants had no problems with the physiological devices 'didn't bother me it was fine' [Sally, R]. Seven of the ten participants had an impartial reaction to the electrodes. No interference was stated as to the intervention delivery, accordingly with similar accounts reported in Block 1. The consistent findings across blocks indicates the use of the physiological equipment did not affect the comfort or attention of participants during the delivery of the intervention.

b. Disruption to questionnaire response

Three of ten participants noted having the electrodes on their non-dominant hand made it a little harder to type. For example;

> 'ye it's a little harder to answer the questionnaire but apart from that all ok'
> [Suzie, N]

Changes to the electrode placement could not be made due to the time needed for the electrodes to acclimatise to the skin (skin and electrode hydration). Despite the difficulty in typing, the use of the electrodes only caused mild inconvenience to questionnaire completion which was deemed as acceptable for the protocol.

4) Researcher assessment:

At the end of Block 2, a validated measure of perceived stress was included in the protocol at pre-intervention and at 1-, 3- and 6-months post-intervention. The Perceived Stress Scale (PSS) (Cohen et al., 1994) provides information on the level of stress in the previous month. Stress, as discussed in Chapter 2, could act as a major barrier to smoking cessation (Cohen and Lichtenstein, 1990). Therefore, information on the level of stress perceived by the participant in the month previous to the delivery session and, afterwards, was needed in order to control for the potential impact of general levels of stress on the intervention success.

6.4.3 Block 3.

1) Intervention delivery:

No sub themes were identified for intervention delivery within Block 3 of recruitment

2) Questionnaire content/delivery:

No sub themes were identified for questionnaire content/delivery within Block 3 of recruitment

3) Physiological measurement:

a. Impartial reaction to the electrode placement

Further support of the non-invasive nature of the attachments of the electrodes is evidenced in Block 3. Nine of the ten participants expressed an impartial reaction to the intervention.

> 'fine ye it was like when you paint your nails and you can't touch anything (2) but ye it didn't feel like you had anything on' [Leanne, R]

With some of the participants noting that it was interesting to have their physiological state measured while it remained comfortable to wear.

> 'it was cool it was a little bit exciting ye no it wasn't invasive at all it was just really interesting and um not uncomfortable' [Claire, N].

Due to similar findings across blocks regarding the physiological measurements, conclusions can be drawn. The equipment used to make physiological measures can be considered as comfortable, not stress inducing for the participant, and non-distracting to intervention delivery. Therefore, no changes were made to the placement and instructions to participants regarding electrode attachment for the RCT.

5) Researcher assessment:

An additional single item question regarding the number of cigarettes smoked in the 24hrs prior to testing was added to the pre-intervention questionnaire. The addition was made in order to verify the objective measure of smoking behaviour (CO breath). Participants were asked to provide a carbon oxide (CO) breath sample that measured the proportion of CO to oxygen (O) in the participants lungs at time of measure. Therefore, self-reported smoking behaviour from the 24 hours prior to testing was introduced to support this objective measure with self-report information.

6.4.4 Summary of protocol changes.

After assessing the participant perceptions regarding the research protocol, a number of protocol changes were made at each block of recruitment. Fig. 13 illustrates the summary of changes made, and when they were adopted in the study. The changes implemented comprised of amendments to the intervention delivery, in the form of extending the Morphing phases to include 'Freetime'. This development took into account the experience of the participant viewing the intervention content, allowing for the intervention image to be explored in greater detail by the participant. Other changes made were to the content and wording of questionnaires. This ranged from inclusion of additional measures and gaining more demographic information from participants. The information gained from participants regarding the questionnaire was essential to understand from the point of view of the participant how it felt to complete the questionnaire. The most crucial information gained from the qualitative protocol development was the assurance that the inclusion of physiological measurements did not detract from the intervention delivery. As physiological measurement has not been a utilised by previous research on the intervention, confirmation of low disruption was needed to ensure engagement with the intervention.

6.5 Conclusion

This chapter outlines qualitative data collection and analysis carried out to fulfil the protocol development aim of pilot study. Participants' perceptions of the research protocol were explored, and assessment of how the protocol could be improved and developed for the final RCT study was made. Participants' suggestions from the individual interviews conducted directly after the intervention administration and focus group discussed held after each block of recruitment were reviewed for each block of recruitment. Suggestions gathered and the researcher assessment of the block were evaluated and later actioned in the RCT investigation (Chapter 9). Overall, the inclusion of physiological measures was deemed acceptable by participants and most importantly did not distract participants from the intervention images. The Chapter 8 outlines quantitative results obtained from the mixed methods pilot investigation. Quantitative data collection was performed alongside qualitative within the pilot study, in order to assess the quantitatively derived aims of the study.

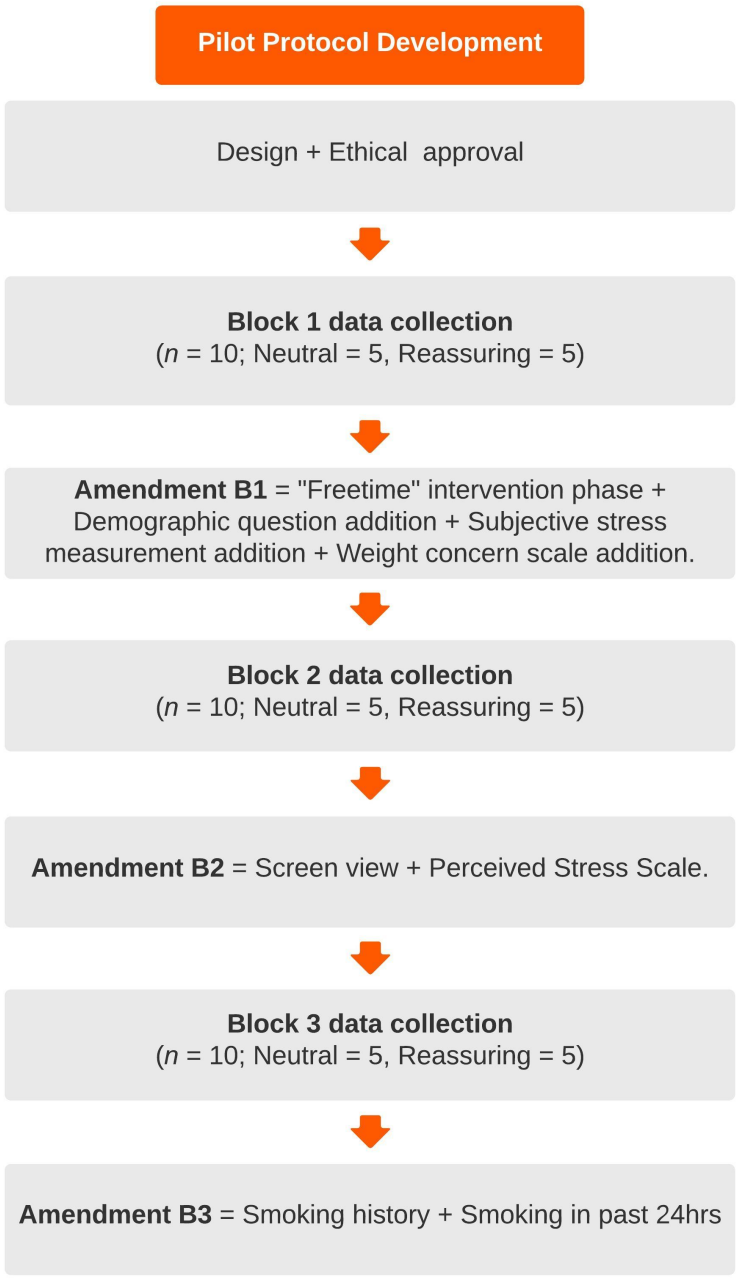

Figure 13 *Flow diagram to illustrate block developments within the pilot, through protocol developments and amendments.*
Note: Number of participants recruited and randomised within each block specified

7 Chapter 7: Exploration of women's experiences engaging with the age-progression intervention.

7.1 Introduction

Chapter 6 above illustrates the qualitative analysis and outcomes that feed into the development of the protocol, implemented in the later RCT study. Within this chapter, additional qualitative findings from participants experiences of receiving the age-progression intervention were explored, using responses obtained within the pilot study data collection. Discussion of the results reflects on themes uncovered in previous research and wider discourse surrounding health and appearance.

7.2 Background

As explored in previous chapters, appearance is of growing importance in today's Western societies (Grogan, 2017). Post-feminist perspectives introduced through media normalise the pursuit of perfection in appearance and health (Riley et al., 2018), with significant social pressure on women to maintain a youthful appearance across the lifespan (Grogan, 2012b). Part of the natural ageing process is facial wrinkling, due to biological and genetic factors alongside external conditions such as ultraviolet exposure and cigarette smoke (Clarke and Korotchenko, 2011). Interestingly, in relation to smoking behaviour, focus groups with young women have suggested that motivation to quit smoking could be increased if the effects of smoking on an individual's own appearance were made more evident (Grogan et al., 2009).

Age-progression interventions for smoking cessation, harness the attention paid to appearance in order to reduce smoking behaviour. The impact of age-progression facial morphing interventions for smoking cessation has been previously investigated (Flett et al., 2013; Burford et al., 2013; Burford et al., 2017; Bush et al., 2012; Bloom et al., 2016; Song et al., 2013). Quantitative research has presented positive results for the intervention's ability to change smoking behaviour and attitudes (Grogan et al., 2011; Burford et al., 2013).

Previous qualitative work has investigated the experience of both female (Grogan et al., 2010b) and male smokers (Flett et al., 2017) while viewing the intervention. Common themes were identified in both papers, the most prevalent being the personal relevance of the intervention. Grogan et al.'s (2011) study with female smokers suggests that viewing the ageing effects on one's own face increased the sense of personal risk of looking older than without smoking effects, which is suggested as the most effective component of the intervention. Additionally, Flett et al. (2017) presented a similar core theme of "personal

relevance" in their work with male smokers. For the male participants, personal relevance enabled the participants to feel at risk to from the intervention; the importance of the theme is highlighted by its connection with all the other themes that were present (such as, intention to quit smoking and concern over ageing) making personal relevance a crucial indicator of the intervention's likely success. Researchers have aligned these findings with Protection Motivation Theory (PMT) (Maddux and Rogers, 1983) that proposes when individuals feel personally at risk from a negative health behaviour, they are more likely to change their behaviour. The intervention may enhance the feeling of personal vulnerability, to the negative consequences of smoking, by showing how smoking causes accelerating ageing to their own face.

Another common theme in both previous qualitative papers (Flett et al., 2017; Grogan et al., 2010b) is the "shock reaction", described as the feeling of a surprise in reaction to the morphed aged image. Grogan et al. (2011) found that women reported feeling shocked by their smoking aged images, in some cases to an extreme extent. Similarly, Flett et al. (2017) reported the subtheme of "shock reaction" (which was placed under the theme of "concern over ageing") that included participants accounts of experiencing the intervention as "shocking" and sometimes "scary". Whether as a theme or subtheme, both papers (Grogan et al., 2010b; Flett et al., 2017) reported the shock reaction as an important aspect of the experience induced by the intervention. Although, as noted above, similar themes were present in both studies (Grogan et al., 2011b; Flett et al., 2017), not all the participants seemed to share the same concerns or fear regarding ageing. For example, while concerns for the ageing effects of smoking were generally reported by female smokers (Grogan et al., 2011), in Flett et al.'s (2017) investigation in male smokers, a subgroup of participants did not express this concern. These results are highly relevant, as findings from the subgroup highlights how the intervention could possibly be more effective in participants who are appearance focused.

Previously published qualitative research on age-progression interventions for smoking cessation explored above has its limitations. Firstly, research focused on young smokers (below 35 years old), when there is evidence to suggest that women between 35-55 years are also responsive to the intervention (albeit in the context of sun damage; (Persson et al., 2018a). Furthermore, in Grogan et al.'s (2011b) study women were recruited from UK Stop Smoking Services and therefore could be considered highly motivated to quit. Additionally, it has been eight years since Grogan et al.'s (2011b) qualitative investigation of the

experience of women who engaged with the age-progression intervention for smoking. Since 2011, popularity of face ageing and face changing apps has risen (Rajanala et al., 2018).

As indicated in the above systematic review (Chapter 3) there is a lack of qualitative research that investigates age-progression interventions for smoking cessation. This current qualitative investigation in addition to the pilot study, aimed to explore the experiences of women aged 18-55 years who smoke given the age-progression facial morphing intervention. The study addressed limitations questioned in previous research by extending the age range of participants, recruiting from the general population and not just stop smoking services and updating our understanding of women's experiences of the intervention in a more recent setting. Through investigating this additional aim, the thesis contributes to the wider qualitative research literature regarding age-progression interventions for smoking cessation.

7.3 Method

The aims of the study were accomplished using data from individual interviews and focus groups collected as part of the pilot investigation. In addition to questions regarding the development of the protocol, participants were also asked open ended questions in order to share their experiences of engaging with an intervention of this type. Question topics covered attitudes towards the intervention (e.g. '*what did you think about the intervention'*) and feelings towards the intervention, including impact on smoking behaviour (e.g. '*how did you feel when you were doing it*?'). Furthermore, the present study implemented one of two instruction types during the intervention delivery. Qualitative comparison of the experiences of participants within each instruction type was used to highlight gaps in understanding and challenge assumptions made from previous research.

All information regarding data collection, transcription and analysis of the qualitative responses was outlined in Chapter 5 methodology (sections 5.4 and 5.8.1). Below the results are presented for the qualitative exploration. Participant characteristics are as outlined in Chapter 6. Pseudonyms, age, ethnicity and level of smoking behaviour can be found for each participant in Tables 7 and 8, found in Chapter 6.

7.4 Results

Pseudonyms and age of the participant appear within square brackets at the end of quotes. If the quote is derived from focus group discussion the acronym FG will appear within the square brackets at the end of the quote, individual interviews will be indicated by I. If the

participants received the Neutral instructions this will be indicated by N the Reassuring by R. Information about the number of participants and mix of instruction types in each theme and subtheme is provided in square brackets e.g. [12/30 N 10, R 2]. Fig. 14 illustrates all themes, subthemes and links between themes in a thematic map.

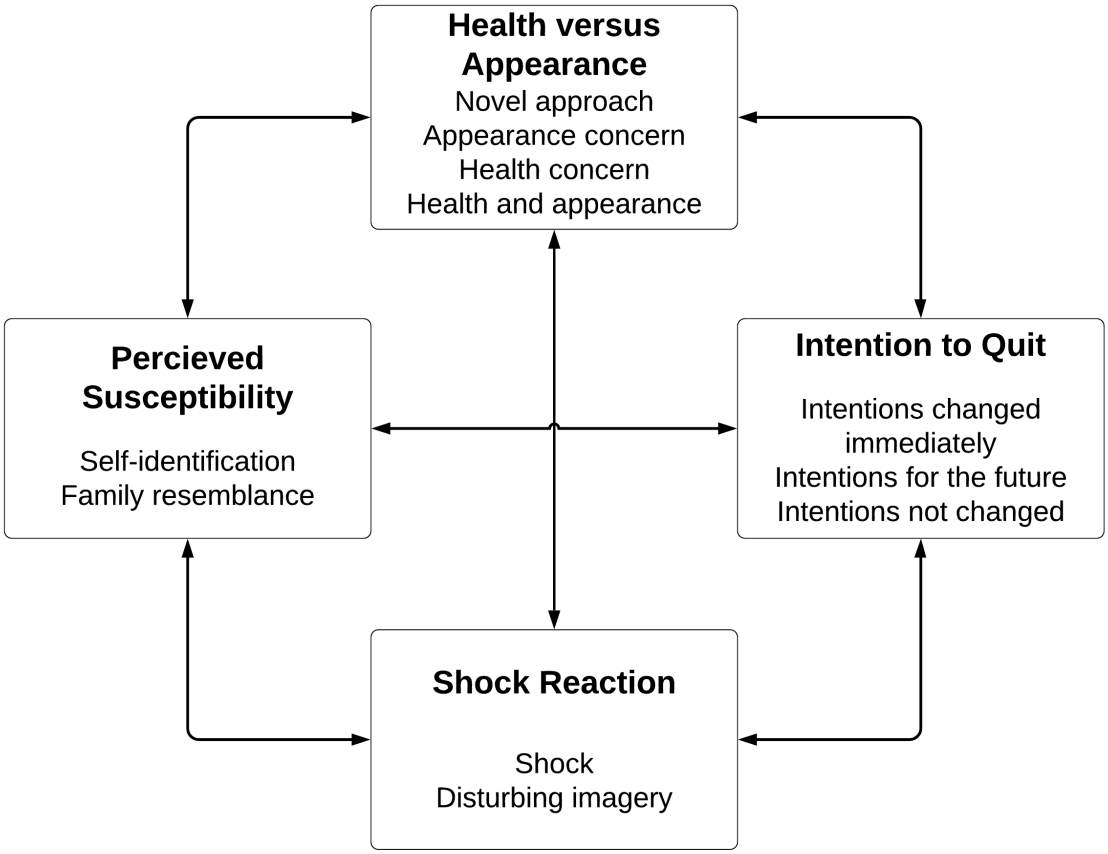

Figure 14 *Thematic map of themes relating to the exploration of participants experiences of the intervention.*

7.4.1 Theme One - Perceived Susceptibility

The first theme identified is Perceived Susceptibility to the skin wrinkling effects of tobacco; this encapsulates how participants felt while viewing their own face morphed and how identifying with the image affected the impact the intervention had on the participant. Within this theme are two subthemes, self-identification, and family resemblance. The first is the subtheme of 'self-identification' with the image [12/30 N 10, R 2]. The majority of participants [n = 10] whose accounts fell within this theme were administered the Neutral instructions. Participants within this theme were able to relate to the image and mentioned the damaging effects of tobacco on their faces (or lack of) and stating feelings of susceptibility or vulnerability to these effects in the future. For example:

> ‘It’s definitely a personal thing cus you always think like you would be the one person it didn’t happen to but then seeing your face change is creepy and you are like ok this is real and this could be a thing and ye’ [Bridget, FG, R].

However, some participants had difficulty in relating to the intervention image, and reported feeling that the images were unrealistic:

> ‘It more feel like it’s just a filter and like it’s not so real like it’s hard to picture yourself” [Anne, FG , N].

Nevertheless, the accounts within this subtheme mostly reported self-identification with the pictures and feeling vulnerable to the harmful effects of tobacco. The perceived susceptibility to tobacco damaging effects were directly linked to the novelty of the intervention and seeing the ageing effects on their own face, as the threat felt personal.

The subtheme of self-identification and the feelings of personal threat is further supported by participants accounts of having previously seen pictures depicting the negative effects of smoking (e.g., from images on cigarette packaging). Participants are aware of the negative consequences these images depict but do not feel at risk from them in the same way as seeing the effects on their own face. For instance;

> ‘Urm I would agree with Sarah that I thought like that there wasn’t really anything you could have shown me that I didn’t already know about that smoking bad and everything (.) but you see old hands on packets but I think what it was after thinking about it the whole image stuck with me for a bit (.) I think cus it was actually me rather than some ladies hands or some bad smokers ugly lungs (.) it was me and I think because it was a bit more personal like that I took it on a bit more seriously than I would if I saw just someone having a heart attack or a cigarette packet or something yeah’ [Mary, FG, N].

Another subtheme within Perceived Susceptibility is an identification with ‘family resemblance’ [15/30 N 8, R 7]. Participants related the intervention age-morphed images to members of their families, who either smoked or did not smoke. If participants saw resemblance between the image and an older family member, it enabled them to perceive the effects of smoking on ageing as depicted in the morphed images as realistic. Participants were then more likely to believe it could happen to them in the future:

> ‘The left one [non-smoking image] looks like my grandma when she was 72 (.) my grandma was a non-smoker by the way urgh and the right one looks like my mum

does now and she's only sixty she's a heavy smoker and all I can think is botox and filler can't sort that out' [Laura, I, N].

However, if the resemblance with the family member was not coherent with that family member's smoking behaviour, the participants' belief in the reliability of the images showing the damaging effects of smoking on ageing was reduced:

'There was some disbelief with me I thought my mum that's eighty (.) she looks like that anyway and she hasn't smoked a cigarette (.) so some disbelief but it's still has some impact I would say (.) it makes you think about how you age and I suppose the comparison' [Elaine, FG, N].

7.4.2 Theme Two – The Shock Reaction

A major theme throughout the interviews and focus groups was a 'shock reaction', which includes two subthemes: "shock" and "disturbing imagery'. Twenty participants accounts were related to 'shock' [20/30 N 8, R 12]. There is a clear majority of participants, who were administered the Reassuring instructions, in this theme [N 8, R 12]. The subtheme 'shock' includes feelings of shock, stress, anxiety and fear. Mild shock, was linked to an interest with the intervention content:

'It was really interesting to see myself grow old, it was interesting to see the two next to each other and the comparison erm and how much affect smoking really does have to your skin, its urgh quite shocking really' [Laura, I, N].

Severe shock was also reported, where participants felt scared of the intervention image which linked to concerns over appearance:

'I thought it was terrifying' [Bridget, I, R] and 'oh yeah yeah yeah (.) shit that's a bit scary (.) that's very scary, it's so much more wrinkle there's so many more wrinkles' [Leslie, I, R].

Participants in the Reassuring instruction type expressed more intense shock from the intervention images which could have affected their experience of the intervention overall. For instance, 'Literally just pure shock (.) I don't know it's just not something you are used to is it' [Becky, I, R]. This divide in the instruction types within this theme indicates that the Reassuring instructions, although intended to reduce the shock reaction, had the opposite effect.

Another subtheme within this theme is the expression of 'disturbing imagery' [12/30 N 5, R 7], which again was more prevalent within this Reassuring instruction. Some participants compared the age-morphed images to disturbing characters from horror stories including witches, mummies and monsters:

> 'It's just grim absolutely grim it's unbelievable the difference, that almost looks like um like a face from like urgh a horror story like the villain in a horror story like a witch or something and that just looks like an old lady (.) you know what I mean?' [Leslie, I, R].

The disturbing imagery voiced by participants also included real life scenarios such as facial disfigurement:

> 'Ye the right one looks old really old (1) even around the chin it looks really old the one on the right looks more like a burns victim' [Laura, I, N].

This participant (Laura) compared the smoking image to that of a burn's victim. Traditionally burns to the face are viewed as horrific and painful, and also shocking to see. Therefore, this disturbing image of their predicated ageing could potentially 'shock' participants to a great extent, relating to changes in their smoking intentions.

7.4.3 Theme Three - Health versus Appearance

The theme 'Health versus Appearance' appeared throughout the transcripts and included three subthemes that explore both appearance and health concerns, and their combination. 'Appearance concern' [14/30 N 5, R 9] was a strong subtheme with 14 out of 30 participants stating some appearance concerns, the majority of them [n = 9] being from the Reassuring instruction condition. During the intervention, the participants expressed concerns over their own appearance focusing on the smoking age-morphed image:

> 'Like you get wrinkles where you just generally do when you get old but on the smoking one you are getting them pretty much everywhere on your cheeks and under your eyes are like really black which is one thing I actually do worry about because I naturally have dark bags and the neck urgh' [Chelsea, I, N].

These concerns were very personal to the participant, and in some cases the concerns created feelings of disgust and attempts to avoid looking at the image:

> 'I really don't want to look at it, what is this horrible person in front of me? I don't want to look at it' [Zara, I, N].

Participants also stated that the intervention appealed to them due to the appearance based nature of the intervention as opposed to traditional health approaches:

> ‘Fertility is obviously a massive thing for men and women but it talks about male impacts and tumours and that and I think at the age that I am and I am an unhealthy person anyway (.) but just at the age that I am I don’t think that impacts me as much as something like that [intervention] would in our generation of social media and selfies and filters’ [Leslie, I, R].

The quotes above suggest that participants were concerned about the appearance of the smoking aged-morphed images more than the health effects of smoking, making reference to the current climate of face changing technology. This finding suggests that including appearance-related factors in smoking interventions could appeal to women more than traditional health-related intervention approaches. This may be due to women’s increased interest in appearance and appearance-related information.

While a majority of participants noted appearance concerns and appearance as a priority (*n* = 14), a small subgroup of participants (all of them administered the Neutral instructions, *n* = 4) were solely focused on ‘health concerns’. These participants were not affected by appearance, instead they stated being affected by health risks of smoking.

> ‘Personally I feel like the intervention would have worried me more if the visual effects of ageing would have been accompanied with like and also you are gonna have trouble breathing or you are gonna have health problems (.) cus ye I don’t really mind how I’m gonna look when I get old cus I will just be old as old people look old (.) but if it was you will be old and in poor health I think I would have been more shaken with it’ [Simone, FG, N].

While appearance was of no concern to these individuals who preferred to focus on how smoking could affect their overall health, viewing the smoking-aged images made them more curious of how smoking would affect their internal physical wellbeing as they aged:

> ‘I was more worried what it would do inside whether it would slow me down, you know what I mean? Cus what I look what I look you just get used to the way you look it doesn’t happen overnight you know (1) but that’s what made me think well it does that to your skin what does it do on the inside you know (.) yeah so ye it’s made me think that’s for sure’ [Suzy, I, N].

Although the subthemes 'Appearance concern' and 'Health concern' are placed in contrast to each other by some participants, a large number of participants [14/30 N 5, R 9] also stated that the appearance focus of the intervention supported their existing health concerns and efforts to change their behaviour. These accounts were included in the subtheme health and appearance. Participants shared personal experiences of health concerns from family members and friends, explaining how the effects on the appearance adds an additional layer of concern and therefore motivation to quit;

> 'Think the picture alone didn't necessarily change my behaviour but it added to other things that were happening around the same time cus I have this circulation problem running in my family and I was thinking god I'm not even forty you know I'm gonna have like really bad circulation in my legs or something so umm with the picture it sorta got me thinking about not wanting to look like a smoker cus you can tell can't you?' [Jane, FG, R].

Other participants stated the intervention supports health interventions they were undertaking at the same time, linking to the novelty of the intervention and the shock reaction it creates:

> 'I had already gone to my GP for champix [prescription intervention] because that was the only thing I hadn't tried so I'm currently trying that but as you will see from my questionnaire I have literally tried everything else so I'm at that stage where I literally have to give up so if this [appearance intervention] along with the champix is a constant reminder each time I light a cigarette to aid the process then it's all to the good isn't it' [Veronica, I, R].

Participants explained how they had taken action into seeking help to reduce their smoking behaviour, and how the appearance intervention solidified their intentions at this time:

> 'Like I said I've gone to the doctor and asked her about things erm so I have um what you call it inhaler? ye those ones and then I also have a vape thingy but I don't really like it (.) so I'm taking the steps I'm not saying I'm quit I'm free um but I have started cutting down so I would say it's all came together with my health and everything and my mum nagging me having to go outside every time so maybe the intervention came at the right time ye that's what I feel (.) it came at the right time' [Mary, FG, N]

This subtheme therefore suggests that women found the intervention useful to support existing health messages and interventions, the mechanism for this potentially being the novel focus on the appearance approach and the 'shock reaction' that elicits.

7.4.4 Theme Four - Intention to quit

'Intention to Quit' was one of the most prevalent themes within the data, which included four subthemes key to its understanding: 'intentions changed immediately', 'intentions changed in the future', 'novel approach' and 'intentions not changed'.

In the individual interviews and focus group discussions the participants were asked whether they believed their intentions towards smoking had changed as a result of the intervention. The subtheme 'intentions changed immediately' [12/30 N 4, R 8] illustrates that 42% of the participants stated they would change their behaviour as a result of the intervention. The intention to reduce smoking was linked to a motivation to change how their skin will age overtime. Out of those participants, eight were administered the Reassuring instructions while only four were given the Neutral instructions. For instance, participants gave clear affirmative plans to quit smoking:

> 'Yeah one-hundred percent I don't want to smoke if I'm gonna look like that just cus I don't wanna age that quick and seeing how quick my mums aged I don't wanna age that fast' [Leanne, I, R].

Some women expressed a strong intention to change their behaviour and even felt a state of urgency to stop smoking, that was linked to the theme of the shock reaction:

> 'Just that I want to stop smoking (laughter) and that I think ye just a bit panicky and a bit more aware that its more of an imminent thing than thinking oh I will do that at some point its more of a ye I should really do this now and I still have it in my memory' [Alex, I, R].

The majority of participants who stated an intention to quit immediately were administered the Reassuring instructions, which included phrases such as 'do not be alarmed' and 'don't worry'. As mentioned above, the participants who received the Reassuring instruction were also more likely to express feelings of intense 'shock reaction'. Therefore, the increased accounts of intentions to quit immediately after intervention administration, could be related to having experienced more fear and stress through viewing the age-morphed images.

Other participants did not share the same immediate change in intentions, but did however state the intervention had set an incentive for future change; these accounts were grouped under the subtheme of 'intentions changed in the future', and were gathered from an equal numbers of participants from each instruction type [14/30 N 7, R 7]. For instance:

> ‘yeah in the short run I don’t think it will change much but in the long run I think it will, it will be in the back of my mind and it will help me to stop smoking’ [Kelly, I, R].

Participants stated that the intervention had strengthened their resolve to quit in the future and it would be playing on their mind pushing them towards quitting. This intention to change in the future was linked to appearance concerns such as improving skin condition:

> ‘quitting would be doable it wouldn’t be horrible difficult or really boring (.) it would be um it would probably make me feel really good about myself so that was nice (.) so its strengthened my intentions for the future and it’s nice to think if I did quit I would get better skin for longer’ [Claire, I, N].

Participants’ accounts seem to indicate that one of the key factors involved in the intervention efficacy in increasing intentions to quit smoking was the novel nature of the appearance approach. The subtheme ‘novel approach’ [8/30 N 4, R 4] was linked to intentions to quit and the ‘shock reaction’ experienced by participants. Participants expressed how the age-progression facial morphing intervention was different to other smoking cessation interventions they had tried previously, and how because of this novelty of focusing on the appearance it could be effective to support their quit attempt:

> ‘Um I think it’s really good I think it’s for me as a smoker it will make me look at things differently (.) the leaflet you gave me to read is a very old leaflet I have read it multiple times over very many years that didn’t help me that didn’t support me, this that we have done today is very different from anything I have been exposed to or gone through with a view to give up smoking so it’s definitely a totally different dimension to think about other than (2) I can’t at this point say but it would be interesting for me to think if every time I have a cigarette now I am very very much more aware of some of the not just the physical effects but the appearance effects and things (2) um so ye I think it’s given me a different angle to think about giving up from’ [Veronica, I, R].

The novel nature of the intervention focusing on appearance was linked to the ‘shock reaction’ participants experienced:

> ‘I think it’s good for me to see that because I have been mainly focused on how smoking might affect my health and see that as a main reason why I am considering to stop at some point (.) but seeing it physically as well is just another aspect I haven’t really thought about so that’s a bit shocking to see that.’ [Gemma, I, R].

Participant responses indicate the combination of the shock and seeing a new type (novel) intervention focused on appearance, gave them another aspect to consider and another reason to quit.

Finally, a small subgroup of participants stated that the intervention had not made any impact on their intentions [$n = 4$] creating the subtheme of 'intentions not changed'. For example:

> "No I don't think so (.) I might be thinking about it for half an hour but after that I am pretty sure I will continue to smoke" [Tabitha, I, R].

Participants whose accounts fall under this subtheme were evenly split between both instruction type groups [4/30 N 2, R 2] indicating these participants shared a common lack of motivation to quit, which they believed did not change as a result of the intervention.

7.5 Discussion

7.5.1 Summary of the results

Through qualitative analysis, four themes were identified that inform our understanding of 19-52 year old women's experiences of the age-progression intervention for smoking through different instruction types. The themes included; 'Perceived Susceptibility', 'The Shock Reaction', 'Health versus Appearance', and 'Intention to Quit'. Each theme was interlinked and partially echoed those of previous qualitative work (Flett et al., 2017; Grogan et al., 2010b), despite the growth in popularity of face age apps, and the increase in age range of participants relative to previous studies.

One of the major themes within this study was 'The Shock Reaction' with $n = 20$ (75%) participants expressing some kind of shock reaction towards viewing the smoking age-morphed image. This was central to women's experiences of the intervention linking to other major themes such as 'Intention to Quit' and sub themes including 'appearance concerns'. The shock expressed by participants was directed at the smoking-aged images and included the use of disturbing imagery that related to negative ageing stereotypes of women, commonly observed in modern media (Loos and Ivan, 2018). Negative representations of ageing women have been linked to increased negative body image (Grogan, 2012b). However, the participants only appeared shocked by the smoking aged images, and related to the non-smoking natural aged images positively, as seen in previous research on the intervention in the context of sun damage (Persson et al., 2018a). Previous research also indicates that health behaviour change interventions that contain fear responses increase

stress and appear to have a positive impact on smoking cessation outcomes (Tannenbaum et al., 2015). Therefore, the level of shock experienced by the current sample may be indicative of future quit attempts, although the researchers recognise that responses within an interview setting may not directly relate to behaviours in other social contexts.

Importantly, though contrary to expectations, 12 of 15 (80%) participants given the Reassuring instruction reported experiencing the 'The Shock Reaction'; while accounts related to this theme were stated by only 8 of 15 (53%) of the participants given the Neutral instructions. It is likely that by providing reassuring statements such as 'Do not be alarmed' may have primed the participants into feeling alarmed by the images, as fear-related words (such as "alarm", "worry") can induce fear and anxiety by activating brain areas involved in emotional processes (Isenberg et al., 1999; Maddock et al., 2003). This paradoxical effect of the reassuring instructions aligns with the Ironic Process Theory (Wegner, 1994) that proposes that deliberate attempts to supress certain thoughts could make them more likely to appear, specially under conditions that reduce cognitive capacity (such as, under stress). Research in children has shown that providing reassurance before a painful medical procedure increases instances of fear (McMurtry et al., 2010; Blount and Cohen, 2000). Although this reaction has yet to be replicated in adults, it could explain the increase of instances of shock reaction in the Reassuring condition group, as these participants were given "reassuring" instructions while viewing the age-morphed images.

After taking part in the intervention, 20 of the 30 participants, reported positive intentions to change behaviour; these intentions included clear affirmations to quit, contemplations of quitting and reducing amounts of cigarettes consumed. Those delivered the Reassuring instructions were also more likely to have 'Intention to quit', specifically in the subtheme 'intentions changed immediately' ($n = 8$). These intentions to quit are expressed in the same group of participants that experienced greater levels of shock. It could therefore be argued that the more shock the participants experienced, the more likely they were to state intentions to quit. Recent research suggests that high (compared to low) levels of negative emotions experienced by the participants, equate to increased number of quit attempts (Cho et al., 2018). Therefore, the increased accounts of intentions to quit in the Reassuring condition group, could be related to the increase of shock reaction and negative emotions induced by this set of Reassuring instructions.

As a note worth mentioning, while shock and fear could have a positive impact on immediate intentions this may not translate to long-term behaviour change. For example, the curvilinear

model of behaviour change (Tannenbaum et al., 2015; Higbee, 1969; Millman, 1968) suggests that compared to moderate levels, both, very high and very low levels of fear reduce attention and affect negatively memory consolidation, inducing a lower impact on behaviour change. In this regard, if the set of Reassuring instructions create an elevated state of defensive and avoidant behaviour, the intervention could be less attended to and may not be remembered in as much detail, as the alternative neutral smoking instructions. To fully determine the short- and long-term impact of the instructions type on the shock reaction and behaviour change, a large longitudinal RCT with long-term follow up should be carried out.

'Health versus Appearance' is a theme that has not been identified in previous research on age-progression interventions for smoking. The theme suggests that, in relation to approaches to smoking cessation, some participants had a preference for paying attention to appearance, while a subgroup of participants preferred only health messages, evidenced previously in male participants (Flett et al., 2017). In other participants, the addition of both (health and appearance) in the form of age-progression interventions and medical advice and support could offer a comprehensive approach that appeal to a wider range of women who smoke. As mentioned previously, importance is placed on women's appearance in Western societies (Frevert and Walker, 2014; Grogan, 2017; Riley et al., 2018). Conversely appearance, as a primary motivation for smoking cessation may not be the most effective approach, as indicated in previous health related intervention research (Mroz et al., 2018). Increased interest in being 'health conscious' also coined as 'healthism' has been made possible in current individualistic Western societies (Ayo, 2012; Crawford, 2006) commanding resources and commercialisation of health practice (Lyons and Chamberlain, 2017). Age-progression interventions for smoking could utilise attention paid to both appearance and health effects of smoking, harnessing existing infrastructure built around 'healthism'. A combination of approaches could provide an effective method to support a range of women. Previously research on age-progression interventions has trailed this approach, introducing the intervention into a pharmacist setting delivered alongside pharmacist advice. The approach was indicated as effective in reaching a wide range of socioeconomic areas (Burford et al., 2013).

The theme 'Health versus Appearance' was linked to the theme 'Perceived Susceptibility'. Through visualising the damaging effects of tobacco, the participants perceived susceptibility is increased alongside the awareness of personal vulnerability to the harmful effects of cigarette smoke on their appearance; and by extension, to their own health. As the PMT (Maddux and Rogers, 1983) suggests that personal risk is a key component to

behaviour change, the efficacy of the age-progression interventions for smoking cessation will likely be increased by targeting women with existing appearance concerns, who will be more likely to perceive risk from the smoking aged morphed image. In addition, a small subgroup of women did not express any intentions to quit smoking after viewing the age morphed images; some expressed reasons for this indicating that currently smoking was a social norm within their existing relationships. The PMT (Maddux and Rogers, 1983) describes how if smoking provides extrinsic rewards the benefit of smoking may outweigh the personal risk. This indicates that the threat elicited by the age-progression intervention may not have been strong enough to outweigh the rewards of increased social interaction associated with their existing smoking behaviour, resulting in less intention to quit.

Some themes that are present in the current findings are consistent with those illustrated in the previous qualitative research (Flett et al., 2017; Grogan et al., 2010b). Themes include the 'The Shock Reaction', 'Perceived Susceptibility' and 'Intention to Quit', that remain core themes in both male and female samples. As in Flett et al. (2017), where it was found a subgroup of male smokers who were not appearance-concerned, the current research also found a subgroup of female smokers who were not appearance-focused and prefer health-related approaches instead. This subtheme suggests that subgroups of both men and women either feel more comfortable discussing health concerns or are less concerned about appearance than other participants. In the present study, within the subgroup of women who preferred health-related approaches, three of these women state no intention to quit and all four stated no shock reaction towards the intervention. The lack of shock was indicative of those participants who were also not concerned about appearance, these two aspects may predict individuals who do not respond to the intervention. However, the theme appearance concern was not present in a previous qualitative study on female smokers (Flett et al., 2013). A possible explanation is that the wider age range of participants included in the present study (18-55 years) allowed for a more diverse sample of female smokers than in Grogan et al.'s (2011) study (<35 years old).

Regarding the efficacy of the age morphing intervention for smoking cessation, present findings support previous quantitative studies that have assessed smoking behaviour and smoking cognitions using theory of planned behaviour assessments (Flett et al., 2013; Grogan et al., 2011). The quantitative research indicated stop smoking intentions significantly increased immediately after the age-progression intervention in a sample of young female smokers (Grogan et al., 2011). The current research supports these findings as the majority of women [n = 20] stated intention to quit immediately after the intervention.

The current findings also extend beyond our existing knowledge by providing new insights regarding factors with the potential of affecting the efficacy of the intervention, such as type of instructions used during the intervention and their effect on the perceived shock elicited by the morphed images.

7.5.2 Implications for smoking cessation

Based on the present findings, three recommendations are made for smoking cessation. Firstly, behavioural health interventions that target appearance should be considered as a viable option to target women from a wide range of ages. Secondly, smoking cessation services and campaigns should incorporate appearance into existing health approaches. A combined approach could more effectively support women to quit smoking. Lastly, health behaviour interventions should follow strict standardised scripts, and service providers should be aware that deviations from the script could have important implications on the targeted behavioural outcomes; even providing reassuring statements, aiming to reduce the level of shock or anxiety, could induce the opposite effect, and increase the anxiety of the participants. Additionally, instructions could make training with age-progression interventions easier, as protocols for implementation would be made available for health practitioners. Although, the present research suggests increased shock is preferential for increased positive smoking intentions further controlled quantitative research is needed to confirm these findings.

7.5.3 Strengths and Limitations

Participants from the general public volunteered to take part, extending and broadening previous work with women recruited from Stop Smoking Services (Grogan et al., 2010b). The study also extended the sample ages beyond the young women who were the participants in other similar studies. However, the majority of women recruited were white and predominantly from a University setting limiting the transferability of the present findings. Future research would benefit from the inclusion of a more diverse sample of participants in terms of ethnicity and socio-economic status (Harwood et al., 2007).

In addition, the qualitative data collection was part of a mixed methods approach. Participants had a number of measures taken including physiological activity such as HR, that could have increased awareness of being monitored throughout the intervention, and in turn affect the way the participants engaged with the intervention and their responses in the interviews and focus groups. However, as it has been discussed in Chapter 6 participants were impartial to the administration of physiological measurements, with 27 out of 30

women stating no distraction, and 6 of these women stated they completely forgot about the physiological equipment. Therefore, it is unlikely the measurement of physiological activity impacted on participants experiences of the intervention

7.5.4 Future research directions

Later research within this thesis incorporates a long-term RCT in order to investigate short- and long- term smoking cessation outcomes in relation to the specific set of instructions and their impact on the 'shock reaction' experienced by the participants during the intervention. Future research beyond this thesis could also combine the appearance-based intervention with a health-based approach, such as nicotine replacement therapies or cognitive behavioural therapies, in order to investigate whether the intervention can be used best to support traditional health approaches.

7.5.5 Conclusion

The results indicate that despite growing interest in face age apps the intervention remains impactful on women, specifically The Shock Reaction remains a strong theme which in turn is suggested to influence quit intentions. Delivery of interventions needs to be taken into consideration when designing future behavioural health interventions, and instructions should be standardised and strictly followed for the services providing the interventions in order to ensure its efficacy.

7.5.6 Reflexive analysis

Reflexivity is necessary in order to consider how the researcher impacted upon the research process (Berger and Berger, 2015). The researcher (PhD student) is a non-smoker and has the belief that smoking has a negative impact on health. The researcher is therefore naive in relation to the lived experience of being a smoker, which made conducting the research and hearing the women's stories an empowering experience (Berger, 2008). This position has helped to avoid becoming hyper vigilant towards the negative aspects of smoking cessation and having a bias to reporting negative affect, rather than the experience with the intervention offered. However, studying in an area that the researcher has no first-hand experience can also be a barrier (Berger and Berger, 2015) as the researcher may not be able to identify subtle expression of themes that would be clear to someone who previously smoked. Although the researcher does not smoke, she has experienced the age-progression intervention for both UV and drinking behaviour and has reflected on her experience.

The gender of the researcher may also have impacted upon the research findings (Kacen, 2006). The researcher being female could have influenced the participants-researcher relationship positively, as participants may have felt more open to discussing appearance concerns with a fellow woman than with a man.

The lead researcher is also motivated to gather positive results from the intervention. Although influence of the researchers' position is unavoidable and important to the research, all interpretation and identification of themes went through a vigorous process that involved other more experienced researchers in order to avoid extensive bias in the results. Furthermore, the researcher is more familiar with quantitative methods of analysis and therefore prescribes to a positivist ideology and is not as experienced with qualitative methods. To overcome the issue of experience, at significant points during the process of data analysis the researcher met with members of her supervisory team who have more extensive experience with qualitative data collection and analysis. This enabled discussion of emerging codes and interpretation of results before writing up commenced.

7.6 Chapter summary

The qualitative exploration presented participants' experiences of the intervention delivery, in addition to the previously described protocol development (Chapter 6). Results indicated that four themes could be identified from participants' accounts in response to the intervention. These themes were related to the intervention inducing i) quit smoking intentions, ii) a shock reaction, iii) appearance and health concerns and iv) perceived susceptibility to the effects of smoking on ageing. The shock reaction was found to be more pronounced in those participants who received the intervention delivered with Reassuring instructions, suggesting that the Reassuring instructions induce an increased stress/shock reaction above the Neutral instructions. This increased shock reaction was linked to intentions to quit, echoing themes from previous qualitative research on the age-progression intervention. Further quantitative research within this thesis will aim to understand the relationship between shock and smoking behaviour in more detail.

8 Chapter 8: Quantitative pilot findings

8.1 Introduction

This chapter outlines the quantitative aspect of the mixed methods investigation, named collectively as the pilot study (note, the pilot study section related to the protocol development is described in detail in Chapter 6, and the additional qualitative exploration is presented in Chapter 7). The quantitative aims of the pilot study included assessing the measures of physiological stress, investigated in order to assess whether the intended outcome of the designed instruction types (i.e. Neutral = maintain the level of stress, Reassuring = decrease the level of stress) could be observed and subsequently the instruction types could be implemented in the RCT study (Chapter 9). Additionally, the feasibility of the research was assessed, through monitoring participant retention over longitudinal time points of data collection. Lastly, the quantitative investigation also explored the impact of the intervention on smoking outcomes in order to inform the direction of the RCT investigation. Data is presented for the investigation of the stress response and assessment of participant retention, followed by impact of the intervention on smoking outcomes. Lastly, findings are discussed in relation to the aspects of the study design including attrition and stress measurement.

8.2 Background and aims

Themes presented in the qualitative exploration of the experiences of women with the age-progression intervention (Chapter 7), reflect those of previous research. Intention to quit was a prevalent theme, with participants expressing immediate and future intentions to quit after viewing the intervention images. Importantly, participants reported feeling shocked by the intervention which differed depending on instruction type condition, linking to levels of perceived threat. These findings suggest that participants that were shocked by the intervention images, also felt an increased sense of threat due to the continued action of smoking and the corresponding impact that has on their facial appearance and health. Research indicates that increased perceived threat is a key component to successful health behaviour interventions (Maloney et al., 2011; Witte, 1994). Shock is considered an affective response that can trigger the SNS short-term stress response (Jang et al., 2015). Therefore, the current aims of the quantitative pilot study included investigating if the intervention increased physiological reactivity from pre-intervention (Baseline), as measured by the SNS response. By measuring the physiological response indicative of shock and stress, the intensity of the shock reaction can be quantified and the relationship between stress reaction to the intervention and its impact on smoking behaviour can be investigated.

Two instruction types (Neutral and Reassuring) were designed with the aim of inducing a differential stress reaction to the intervention and introduced within this pilot investigation in order to assess whether this aim was achieved. The Neutral instructions were designed to maintain the level of stress the intervention induced with a minimum of interference from the researcher; while the Reassuring instructions were designed to decrease the levels of stress experienced via empathetic gestures and verbal expressions provided by the researcher delivering the intervention (further details regarding the design of the instruction types are provided in Chapter 5 (section 5.1.2). The qualitative accounts of women experiencing the interventions (as detailed in Chapter 7) indicated that the implementation of the instructions created differences in the expression of shock, which corresponded to differences in accounts of quit smoking intentions. Consequently, another aim of the quantitative aspect of the pilot study was to assess the stress response elicited by the intervention delivered with Neutral or Reassuring instructions, and to establish if the desired impact of instruction types (i.e., inducing a different intensity of physiological reactivity) was achieved.

Hypotheses were developed to gain an understanding of the research findings for later research design and analysis. Research hypotheses include; i) physiological stress response will increase from baseline to during the intervention, ii) physiological reactivity to the intervention will differ between instruction type conditions, and iii) smoking behaviour and cognition will positively change from pre- to post-intervention time points.

In addition, the quantitative side of this pilot study adds to the development of the research protocol. Both the previous (Flett et al., 2013) and current systematic review in this thesis indicates that the level of attrition is a limitation of appearance based intervention research. Research quality could be improved if retention of participants was increased across longitudinal follow up data collection. The pilot investigation therefore aimed to investigate the feasibility of the data collection plan in order to optimise retention of participants in the RCT study. This was achieved through monitoring the recruitment of participants' retention across follow up time points. Information gathered regarding the characteristics of participants recruited, and level of attrition across follow up time points, was used to inform the design and retention strategies within the RCT investigation (Chapter 9). Lastly an exploratory aim of this pilot research was to explore the efficacy of the intervention in relation to the instruction type.

8.3 Method

The study used a two-way mixed measures design. Participants were block randomised into one of the two instruction conditions (Neutral or Reassuring). Measures of smoking outcomes and additional information were assessed at pre-intervention (pre-), immediately post-intervention (post-), and at one (1-), three (3-) and six (6-) months post-intervention. Both conditions received the age-progression facial morphing smoking intervention, delivered with the corresponding instruction type protocol. Measurements of the stress response to the intervention images and instruction types included subjective stress, EDA (EDA Tonic, EDA Amp) and HR. Detailed information regarding the design, procedures, measures of smoking outcomes and stress response are described in Chapter 5 (sections: 5.3.1 for design 5.5.4 for questionnaires, 5.5.2 for stress measurement, 5.7.1 for the procedure).

8.3.1 Participants

Thirty women were recruited through opportunity sampling and block randomised into one of the two instruction conditions (Neutral or Reassuring). Further information on the recruitment and sample can be found in Chapter 5 (section 5.6). For details regarding participant characteristics at pre-intervention see Table 9.

8.3.2 Analysis

Physiological measurements were processed using AcqKnowledge (see Chapter 5 section 5.5.2) and exported to SPSS V.26 alongside all other variables. For details regarding the processing and choices for data analysis of variables, (see Chapter 5 section 5.8.2.1). The results presented below correspond to the aims of the study. Firstly, results regarding the analysis of the physiological stress reactivity is presented, followed by recruitment and retention of participants. Lastly, the exploratory analysis of the intervention efficacy is outlined.

Table 9 *Descriptive data of the sample characteristics at pre-intervention within the pilot study.*

Sample Characteristic	Neutral *n* = 15	Reassuring *n* = 15	Total *N* = 30
Amount usually smoked in a day (%)			
1-5	53%	27%	40%
6-10	20%	33%	27%
11-15	14%	20%	17%
16-20	13%	13%	13%
21-25	0%	7%	3%
Sum of cigarettes *M (SD)*	51.0 (33.2)	76.7 (54.5)	62.5 (46.2)
Age *Mdn (Rng)*	23 (33)	25 (34)	24 (35)
Age category (%)			
<35	80%	80%	80%
>35	20%	20%	20%
Menstrual phase (%)			
Follicular	47%	54%	50%
Luteal	33%	33%	33%
> 28	20%	13%	17%
Test session time (%)			
8-12	20%	33%	26%
12-17	60%	54%	57%
17-22	20%	13%	17%
Stage of Change (%)			
Pre- contemplation	27%	40%	33%
Contemplation	53%	27%	40%
Preparation	20%	33%	27%
HADS anxiety Scale *M (SD)*	9.3 (3.7)	9.3 (4.2)	9.3 (3.8)
HADS anxiety category (%)			
Normal (0-7)	33%	20%	26%
Borderline abnormal (8-10)	20%	53%	37%
Abnormal (10-21)	47%	27%	37%
HADS depression scale *Mdn (Rng)*	2.0 (5)	3.0 (11)	2.5 (11)
HADS depression category (%)			
Normal (0-7)	93%	86%	90%
Borderline abnormal (8-10)	7%	7%	7%
Abnormal (11-21)	0%	7%	3%
Appearance evaluation scale *Mdn (Rng)*	3.4 (27.6)	3.4 (33.4)	3.4 (33.5)
Appearance orientation scale *Mdn (Rng)*	3.4 (44.3)	3.6 (47.4)	3.4 (47.4)
Fagerström *Mdn (Rng)*	1.0 (7.0)	1.0 (9.0)	1.0 (9.0)

Note: HADS A/D= Hospital Anxiety and Depression Scale anxiety/depression. M = Mean, SD = standard deviation, Mdn = Median, Rng = range.

8.4 Results

8.4.1 Normality

Visual inspection of histograms and results from the Shapiro-Wilk test of normality revealed that variables related to smoking intentions, attitudes, subjective norms (SN), EDA measures (EDA Tonic, EDA Amp, EDA Tonic %, EDA Amp %) and subjective stress were non

normally distributed. Variables sum of cigarettes perceived behavioural control (PBC), HR measures (HR and HR %) were normally distributed.

Boxplots for all variables were assessed for outliers. There were some notable outliers in the data. Data used were then tested for studentised residuals, to further assess outliers in the results. If values were greater than, or less than 3 standard deviations from the mean, the data was considered non normally distributed and therefore not analysed using parametric tests. After both assessments it was indicated that data inputted into ANOVA analysis did not contain outliers of concern to the analysis. Mauchly's test of Sphericity was used to test assumptions of sphericity in the data, if value of p >.05 sphericity can be assumed, if sphericity is not assumed Greenhouse-Geiser corrections were applied.

The level of significance will be reported in the traditional sense (p-value <.05), additionally whether effects are maintained after Bonferroni corrections are applied will be reported to enhance confidence in the findings reported.

8.4.2 Internal consistency

Internal consistency was assessed for smoking cognitions scales across follow up time points. Cronbach alpha gives indication of the reliability of scales of this type, however calculating alpha for small sample sizes may limit understanding due to lack of power (Bonett and Wright, 2015). Presented here it is the lowest internal consistency indicated across all follow up time points. Intentions (α = .78), attitudes (α = .66) and PBC (α = .82) indicated acceptable or approximately acceptable reliability, when using the threshold of .70. Scores of Subjective norms reported low levels of internal consistency at first instance (α = .27), which was increased at all other measurement time points, (α = .50-98). See Appendix 6. for all alpha values.

8.4.3 Pre-intervention equivalence

Participant characteristics measures obtained at pre-intervention (identified in Table 9) were assessed to infer if differences could be observed between intervention instructions before implementation of the intervention. Ordinal and binary variables were entered into Chi square tests (Table 10), while continuous measures were entered into independent samples comparisons (Table 11) to assess differences between participants administered two instruction types.

No significant differences were observed in any baseline measure at pre-intervention. Measures of sample characteristics were not analysed further within this pilot investigation but were considered in more detail within the RCT (Chapter 9).

Table 10 *Summary table of Chi square tests for sample characteristic categories at pre-intervention within the pilot.*

Sample characteristic categories	df	X^2	*p*
Age category	1	.00	.674
Amount usually smoke	4	3.03	.552
Menstrual phase	2	.26	.684
Time of testing	2	.76	.684
Stage of Change	2	2.23	.327
HADS A	2	3.59	.166
HADS D	2	1.04	.595

Note: N=30, Age category = +/- 35. HADS = Hospital Anxiety and Depression Scale A-Anxiety, D-Depression. df= degrees of freedom.

Table 11 *Summary table of comparisons between instruction conditions for pre-intervention equivalence tests within the pilot.*

Pre-intervention measure	*t*	*p*	*Cohens d*
Sum of cigarettes	-.92	.367	.40
	U	*p*	*Cohens d*
Appearance evaluation	101.00	.653	.18
Appearance orientation	89.50	.345	.34
Fagerström	99.50	.595	.20

Note: t-tests and Man-Whitney U tests applied, N=30, degrees of freedom (df) =28, Fagerström= test of nicotine dependence.

8.4.4 Stress response to the intervention.

Below outlines results from measures of the stress response during the intervention delivery, including EDA Tonic, EDA Amp, HR and subjective stress.

1. EDA

Values of EDA include measurements of mean EDA Amp (Table 12) and EDA Tonic (Table 13) for each morphing phase.

EDA variables were entered into non-parametric equivalence tests for repeated measures comparisons, in order to infer the effect of morphing phase on EDA variables. The number of participants included in the analyses of EDA Amp was n = 26/30, due to lack of skin conductance responses recorded during some of the morphing phases. Results are outlined in Table 14.

Table 12 *EDA Amp variables, descriptive data across Morphing phases and between conditions within the pilot.*

Morph Phase	EDA Amp (μS)			EDA Amp %		
	Mdn (*Rng*)			*Mdn* (*Rng*)		
	Neutral	Reassuring	Total	Neutral	Reassuring	Total
Baseline	7.5 (20.0)	11.4 (32.1)	8.7 (32.8)	_	_	_
Morph2D	9.0 (19.5)	13.2 37.0)	10.0 (37.1)	14 (36)	12 (28)	13 (37)
Morph2D_R	8.4 (19.0)	12.9 (33.9)	9.5 (34.3)	9 (38)	8 (33)	8 (38)
Morph2D_R'	8.7 (20.9)	12.8 (33.8)	10.0 (34.0)	12 (24)	10 (38)	11 (39)
Morph3D	7.3 (20.9)	11.9 (33.2)	9.3 (33.4)	8 (44)	10 (42)	9 (48)
Morph3D_R	7.4 (21.9)	11.5 (32.4)	11.6 (34.0)	6 (52)	9 (45)	8 (61)

Note: % = percentage of change vs Baseline, Neutral (n =12), Reassuring (n = 14), Total (N=26). [-] = no data collected. μS = microsiemens, Mdn = Median, Rng = Range.

Table 13 *EDA Tonic variables, descriptive data across Morphing phases and between conditions, within the pilot.*

Morph Phase	EDA Tonic Mean (μS)			EDA Tonic %		
	Mdn (*Rng*)			*Mdn* (*Rng*)		
	Neutral	Reassuring	Total	Neutral	Reassuring	Total
Baseline	6.7 (20.3)	10.0 (31.8)	7.6 (33.2)	_	_	_
Morph2D	8.7 (19.3)	12.7 (36.8)	9.2 (36.9)	20 (48)	15 (28)	19 48)
Morph2D_R	8.3 (18.8)	12.3 (33.3)	8.8 (33.6)	15 (47)	14 (32)	15 (47)
Morph2D_R'	8.2 (19.9)	12.3 (33.4)	8.9 (33.8)	15 (36)	13 (32)	13 (36)
Morph3D	7.3 (20.4)	11.4 (32.6)	8.2 (33.0)	10 36)	9 (31)	10 (38)
Morph3D_R	6.8 (21.5)	11.2 (32.2)	8.1 (33.8)	7 (33)	11 (33)	10 (35)

Note: % = percentage of change vs Baseline, Neutral (n =15), Reassuring (n = 15), Total (N=30). [-] = no data collected, μS = microsiemens, Mdn = Median, Rng =Range.

Table 14 *Summary table of Freidman's non-parametric repeated measures comparisons across Morphing phases for EDA measurements within the pilot.*

EDA measure	*n*	X^2	*p*	W
EDA Tonic (μS)	30	73.81	.001	.49
EDA Tonic %	30	76.13	.001	.51
EDA Amp (μS)	26	50.35	.001	.39
EDA Amp %	26	51.28	.001	.39

Note: degrees of freedom (df) = 5, % = percentage of change vs Baseline, μS = microsiemens.

Measures of EDA Tonic displayed a significant main effect of Morph phase (phase of age-progression intervention) (Table 14). Post hoc tests (Wilcoxon related samples test) revealed significant increases from Baseline to Morph2D (Z = -3.03, p = 001), Morph2D_R (Z = -

2.77, p = 001), Morph2D_R' (Z = -3.03, p = 001), Morph3D (Z = -2.03, p = 001) and Morph3D_R (Z = -2.10, p = 001). Bonferroni corrections were applied revealing all differences remained significant at the corrected alpha level of p =.003.

EDA Tonic percentage change also displayed a significant effect of Morph phase (Table 14). Post hoc tests (Wilcoxon related samples test) revealed significant increases from Baseline to Morph2D (Z = -3.88 p = 001), Morph2D_R (Z = -2.77, p = 001), Morph2D_R' (Z = -2.98, p = 001), Morph3D (Z = -2.05, p = 001) and Morph3D_R (Z = -2.12, p = 001) (p <.001). Bonferroni corrections were applied revealing all differences remained significant at the corrected alpha level of p =.003.

Due to non-parametric testing, between condition comparison took the form of comparison at each morphing time point for both EDA Tonic and EDA Tonic percentage change variables (Table 15).

Table 15 *Summary of Mann-Whitney U independent samples, post hoc tests between instruction condition comparisons of EDA Tonic measures, within the pilot.*

Morph Phase	EDA Tonic (μS)		EDA Tonic %	
	U	*p*	*U*	*p*
Baseline	68.00	.065	-	-
Morph2D	72.00	.098	100.0	.604
Morph2D_R	71.00	.089	100.5	.618
Morph2D_R'	69.00	.074	106.5	.803
Morph3D	66.00	.054	110.5	.934
Morph3D_R	65.00	.049	89.5	.339

Note: Neutral (n =12), Reassuring (n = 14), Total (N = 30), μS = microsiemens.

Mann-Whitney non-parametric comparisons for mean EDA Tonic measures, revealed the Reassuring instruction displayed significantly increased EDA Tonic levels versus the Neutral instructions at Morph3D_R, the final morphing phase (U = 65, p = .049). Differences did not remain significant with Bonferroni corrections applied, with a corrected alpha of p = .008. (Fig. 15). No significant differences were observed between instructions at any other Morph phase.

EDA Amp also displayed a significant effect of Morph phase (Table 14). Post hoc tests (Wilcoxon related samples test) revealed significant differences from Baseline to Morph2D (Z = -2.46, p =.001), Morph2D_R (Z = -2.46, p =.001), Morph2D_R' (Z = -2.73, p =.001), Morph3D (Z = -2.15, p =.001) and Morph3D_R (Z =-2.11, p =.001). Bonferroni corrections

were applied revealing all differences remained significant at the corrected alpha level of p =.003.

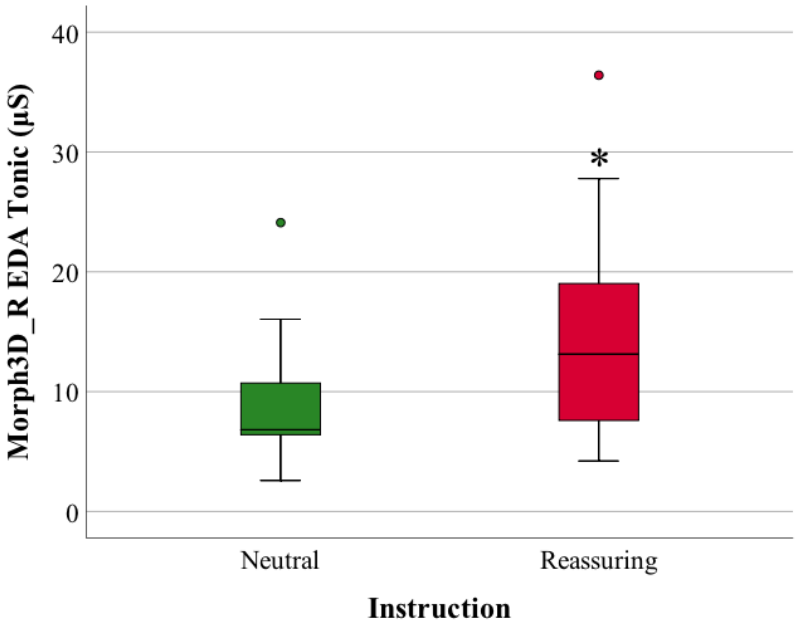

Figure 15 *Box plot to display intervention instruction condition differences in EDA Tonic (µS) at Morph3D_R of the pilot.*
*Note: *, p <.05 Neutral vs Reassuring. µS = microsiemens.*

EDA Amp percentage change from Baseline also displayed a significant main effect of Morph phase (Table 14). Post hoc tests (Wilcoxon related samples test) indicate there was a significant increase from Baseline to Morph2D (Z = -3.42, p = .001), Morph2D_R (Z = -2.37, p = .001), Morph2D_R' (Z = -2.89, p = .001), Morph3D (Z = -2.14, p = .001) and Morph3D_R (Z = -2.00, p = .002). Bonferroni corrections were applied, differences remained significant at the corrected alpha level of p =.003.

Between groups comparison took the form of comparison at each morphing time point for both EDA Amp and EDA Amp percentage change variables (Table 16).

Table 16 *Summary of Mann-Whitney U independent samples, post hoc tests between instruction condition comparisons of EDA Amp measures, within the pilot.*

Morph Phase	EDA Amp (µS)			EDA Amp %		
	n	*U*	*p*	*n*	*U*	*p*
Baseline	27	61.00	.145	-	-	-
Morph2D	29	67.00	.097	27	80.00	.593
Morph2D_R	28	61.00	.098	26	76.00	.680
Morph2D_R'	29	64.00	.074	27	83.50	.716
Morph3D	29	62.00	.061	26	77.00	.718
Morph3D_R	30	65.00	.049	27	69.00	.285

Note: Neutral (n =12), Reassuring (n = 14), Total (N = 26), µS = microsiemens.

Mann-Whitney non-parametric comparisons revealed that the Reassuring instruction condition displayed significantly increased levels of EDA Amp versus the Neutral instructions at Morph3D_R, the final morphing phase (U = 65, p = .049). Differences did not remain significant with Bonferroni corrections applied, with a corrected alpha of p = .008 (Fig. 16). No significant differences were observed between instructions at any other Morph phase.

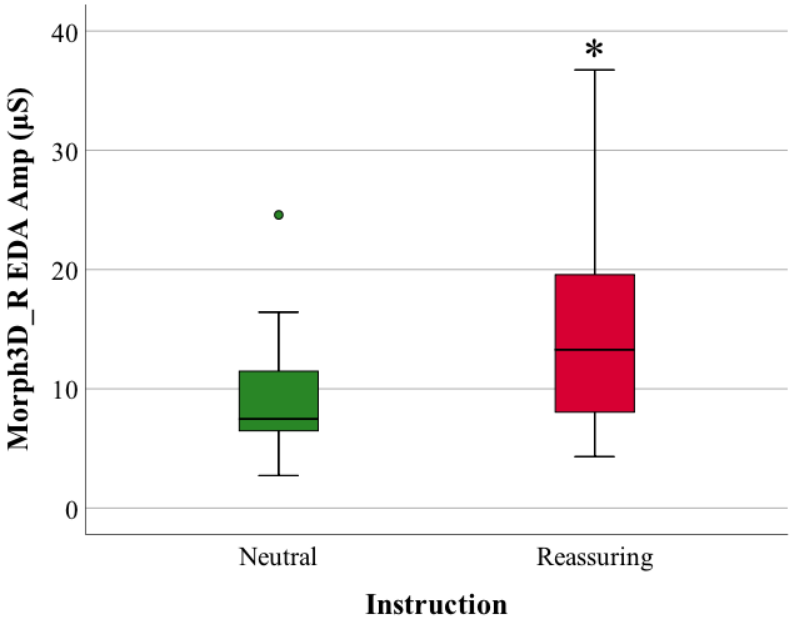

Figure 16 *Box plot to display intervention instruction condition differences in EDA Tonic (µS) at Morph3D_R of the pilot.*
*Note: *,p<.05 Neutral vs Reassuring, µS = microsiemens.*

2. *Heart Rate*

Values of HR were measured at each morphing phase, with the percentage change of HR from baseline calculated for each phase (Table 17).

Table 17 *HR variables, descriptive data across Morphing phases and between conditions, within the pilot*

Morph Phase	HR *(BPM)* *M* (*SD*)			HR % *M* (*SD*)		
	Neutral	Reassuring	Total	Neutral	Reassuring	Total
Baseline	74.6 (13.6)	75.5 (9.8)	75.0 (11.6)	_	_	_
Morph2D	80.7 (13.8)	81.1 (7.8)	80.9 (11.0)	16 (10)	14 (10)	15 (9)
Morph2D_R	77.6 (13.1)	75.8 (8.5)	76.7 (10.9)	11 (12)	12 (10)	12 (11)
Morph2D_R'	76.6 (14.2)	77.6 (8.3)	77.1 (11.4)	12 (7)	13 (11)	12 (9)
Morph3D	77.2 (13.8)	75.6 (8.4)	76.4 (11.3)	9 (11)	11 (11)	10 (11)
Morph3D_R	77.1 (12.1)	76.7 (9.4)	76.9 (10.7)	5 (13)	10 (11)	7 (12)

Note: % = percentage of change vs Baseline, Neutral (n =15), Reassuring (n = 15), Total (N=30), [-] = no data collected, BPM = Beats Per Minute, M = Mean, SD = standard deviation.

HR variables were entered into one-way repeated measures ANOVA analysis, sphericity was not assumed and Greenhouse-Geisser corrections applied. Results were assessed for morphing phase effects and differences between instruction condition, (Table 18).

Table 18 *Summary table representing ANOVA repeated measures results for HR across follow up time points and between conditions, within the pilot.*

Measure	Simple main effect of Morph phase within group				Between subjects' effect of time				Interaction time*instruction type			
	F	*df*	*p*	ηp^2	*F*	*df*	*p*	ηp^2	*F*	*df*	*p*	ηp^2
HR (BPM)	8.87	3.744, 104.833	.001	.24	.00	1,28	.952	.00	.88	3.744, 104.833	.476	.03
HR %	8.92	3.904, 109.317	.001	.24	.66	1,28	.424	.02	1.05	3.904, 109.317	.387	.04

Note: N= 30, % = percentage of change vs Baseline, df= degrees of freedom, ηp^2 *= partial eta squared, BPM = Beats Per Minute*

HR displayed a significant main effect of Morph phase, no significant differences were observed for intervention condition or Morph phase x intervention condition interaction (Table 19). Post hoc pairwise comparisons reveal that HR at Morph2D (*M* difference = 5.82, p <.001) was significantly increased from baseline, the difference remained significant with Bonferroni corrections (corrected alpha p = .003). Additional increases in HR could be observed from Morph2D to Morph2D_R (*M* difference = 4.16, p <.001), Morph2D_R' (*M* difference = 3.75, p <.001) Morph3D (*M* difference = 4.46, p <.001) and Morph3D_R (*M* difference = 3.97, p = .002). Differences remained significant at a Bonferroni corrected alpha level of p =.003.

HR percentage change from Baseline also displayed a significant main effect of Morph phase, no significant differences were observed for intervention condition or Morph phase x intervention condition interaction (Table 18). Post hoc pairwise comparisons revealed that HR percentage change at Morph2D (*M* difference = 7.23, p<.001) was significantly increased from Baseline. Additionally, Morph2D_R' significantly increased in percentage change from Baseline (*M* difference = -2.57, p = .037) although, the difference did not remain significant when the alpha level was adjusted for Bonferroni corrections (p =.003). Significant differences were also observed with increases in HR from Morph2D to Morph2D_R (*M* difference = 5.03, p < .001) Morph2D_R' (*M* difference = 4.67, p < .001) Morph3D (*M* difference = 5.47, p < .001) and Morph3D_R (*M* difference = 4.87, p = .002). All other comparisons remained significant when Bonferroni corrections were applied (corrected alpha p = .003).

3. Subjective stress

Levels of subjective stress were measured at Baseline and at the end of the intervention session. Table 19 provides mean and standard deviation values for all measures, including the total sample and instruction conditions.

Table 19 *Subjective stress, descriptive data across follow-up time points and between conditions within the pilot.*

Time point	Subjective stress *Mdn (Rng)*		
	Neutral	Reassuring	Total
pre-intervention	2 (2)	2 (2)	2 (2)
post-intervention	2 (2)	3 (3)	2 (3)

Note: Neutral (n =15), Reassuring (n = 15), Total (N = 30), Mdn = Median, Rng = Range.

Subjective stress was assessed for differences across time points and between instructions. Wilcoxon signed ranks test indicated only a tendency towards a significant increase in subjective stress from pre-intervention to at the end of the intervention session ($Z = -1.94$, $p = .052$). Mann-Whitney non-parametric comparisons revealed no significant differences between instruction conditions pre-intervention ($U = 105.50$, $p = .775$) and at the end of the intervention session ($U = 81.00$, $p = .202$).

8.4.5 Attrition differences

A number of participants did not complete the follow up questionnaire portfolios at different longitudinal point of the study. Table 20 outlines the number of participants in each instruction type that completed the questionnaires over follow up time periods. Chi-square tests were conducted to assess if attrition significantly varied between instruction types at each follow up time point. There were no significant differences in follow up rates between the two instruction type at 1- (X^2 (2) = 1.15, $p = .282$), 3- (X^2 (2) = .37, $p = .542$) and 6-months (X^2 (2) = 1.29, $p = .256$) post-intervention. These results suggest that participants in each instruction type condition were equally likely to respond to the follow up questionnaires over time.

Table 20 *Summary table of retention and attrition of participants over follow-up time points and between conditions within the pilot.*

Time of data collection	Retention Neutral (*n* / %)	Retention Reassuring (*n* / %)	Total (N / %)
1-month	12/15 (80)	14/15 (93)	26/30 (87)
3-months	13/15 (87)	14/15 (93)	27/30 (90)
6-months	11/15 (73)	8/15 (53)	19/30 (63)

Note: %= percentage of participants that were retained for data collection at the follow up time points

Fig.17 outlines the number of participant responses recorded at each follow up data collection time point.

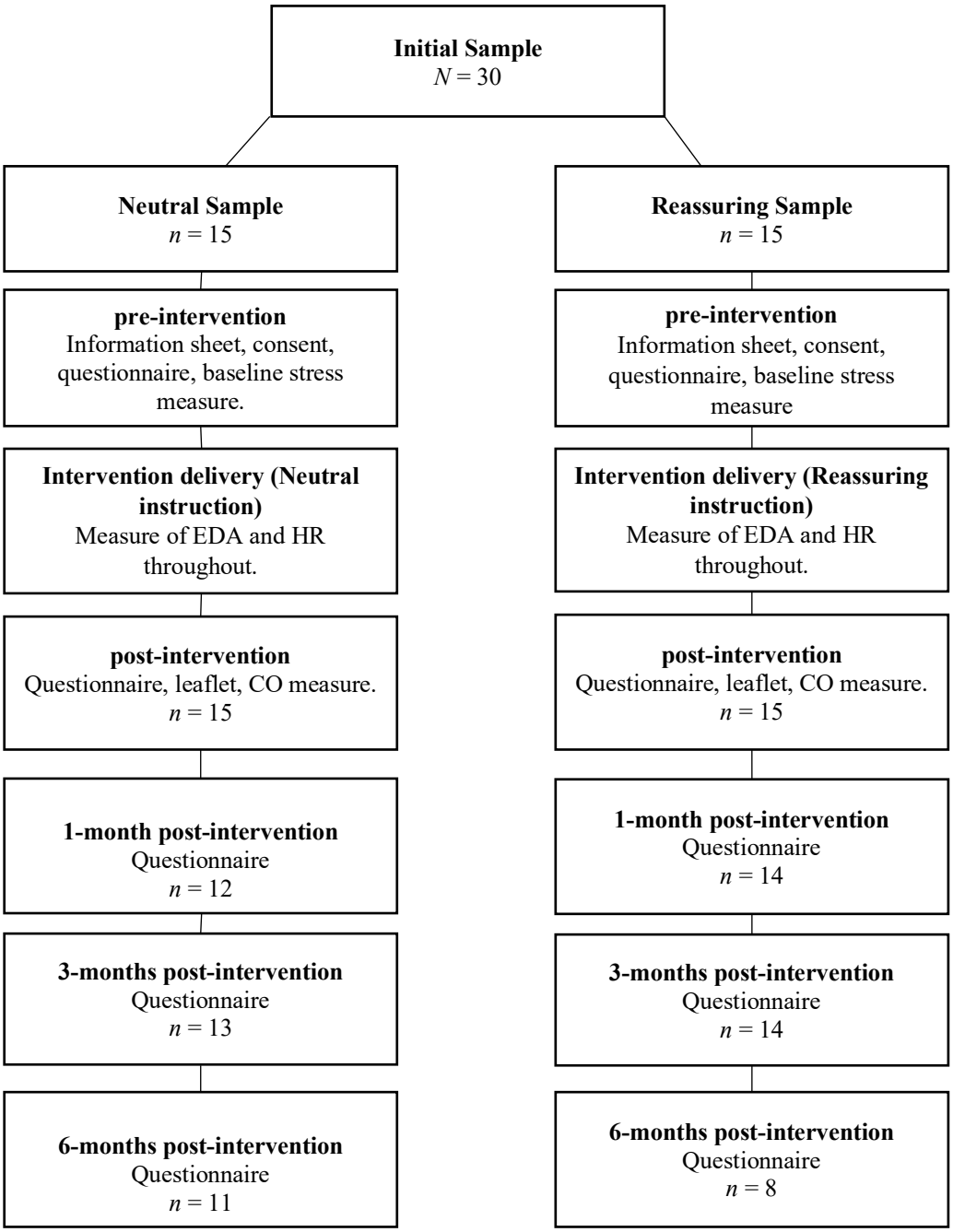

Figure 17 *Flow chart demonstrating the pilot study procedure and retention of participants across follow up data collection.*

8.4.6 Smoking behaviour

Measures of smoking behaviour include the sum of cigarettes consumed, in addition to the presence of a quit smoking attempt at the follow up time points and the report of abstinence 7 days prior to testing. The sum of cigarettes positively correlated to measures of CO breath (r (29) = .41, p = .026), suggesting that as levels of CO breath readings increased in the sample, the level of self-reported cigarette consumption also increased. Signifying that the measure of self-report smoking behaviour may be a valid representation of the participants smoking habits.

Differences in the number of participants who made a quit attempt and displayed 7 day point abstinence was assessed across the instruction type conditions, and follow up time points. Chi square analyses at each time point revealed no significant differences between instruction conditions on quit attempts and abstinence in the week before the follow up time point (Table 21).

Table 21 *Summary table of Chi square tests for the proportion of quit attempts and abstinence between instruction condition across follow up time points of the pilot.*

	Quit Attempt				7 day point Abstinence			
Time of measure	Neutral	Reassuring	X^2 (df)	*p*	Neutral	Reassuring	X^2 (df)	*p*
1- month	5	4	.49 (1)	.484	1	0	1.12 (1)	.290
3- months	7	7	.04 (1)	.842	2	1	.46 (1)	.496
6- months	5	6	.05 (1)	.827	3	1	1.43 (1)	.231

Note: 1-month n = 26, 3- months n = 27, 6- months n = 19, df= degrees of freedom.

In addition to the binary outcomes, the sum of cigarettes and percentage change of sum of cigarettes was measured across pre- and longitudinal follow up time points (1-, 3-, 6-months). Table 22 outlines all means and standard deviations for measurement of the sum of cigarettes.

The number of participants with complete cases of reporting sum of cigarettes at each follow up time point equates to n = 23 (Neutral 11/ Reassuring 12). To assess for effects of time and instruction condition ANOVA repeated measures analysis was conducted for the sum of cigarettes across follow up time points (Sphericity assumed) and the percentage change of sum of cigarettes consumed from pre-intervention (Greenhouse-Geisser corrections applied) (Table 23).

Table 22 *Sum of cigarettes, descriptive data across follow-up time points and between conditions, within the pilot.*

Time of measure	Sum of cigarettes *M* (*SD*)			Sum of cigarettes %		
	Neutral	Reassuring	Total	Neutral	Reassuring	Total
pre-	54.7 (44.1)	70.3 (48.5)	62.5 (46.2)	-	-	-
1-month	25.7 (30.4)	49.9 (38.8)	38.7 (36.7)	45 (32)	25 (26)	34 (30)
3-months	33.8 (33.9)	63.1 (53.0)	49.0 (46.5)	22 (34)	-5 (41)	13 (38)
6-months	34.64 (32.6)	40.0 (46.8)	37.4 (39.8)	60 (61)	-66 (100)	63 (82)

Note: %= percentage change from pre-intervention, [-] = no data collected. pre- (N = 30) (Neutral 15, Reassuring 15), 1-month (n = 26 (Neutral 12, Reassuring 14), 3-months (n = 27 (Neutral 13, Reassuring 14), 6-months (n = 19 (Neutral 11, Reassuring 8). M = Mean, SD = Standard deviation.

Table 23 *Summary table representing ANOVA repeated measures results for sum of cigarettes across follow up time points and between conditions, within the pilot.*

Measure	Simple main effect of time within group				Between subjects effect of time				Interaction time*instruction			
	F	*df*	*p*	ηp^2	*F*	*df*	*p*	ηp^2	*F*	*df*	*p*	ηp^2
Sum of cigarettes	3.42	1.965, 33.41	.045	.17	2.14	1,17	.160	.10	.45	1.965, 33.41	.640	.03
Sum of cigarettes %	5.71	1.358 23.080	.017	.25	.30	1,17	.589	.02	.27	1.364, 24,554	.680	.02

Note: n=19, %= percentage change from pre-intervention, df = degrees of freedom, ηp^2 = partial eta squared.

For the sum of cigarettes, a main effect of time was evidenced, no significant differences were observed for intervention condition or time x intervention condition interaction (Table 23). Post hoc comparisons, showed that the sum of cigarettes consumed significantly decreased from pre-intervention to 1-month post-intervention, with a mean decrease of 23.23 cigarettes (p = .018). However, differences did not remain significant after applying Bonferroni corrections (p = .056) (corrected alpha p = .008).

For the sum of cigarettes percentage change a main effect of time was evidenced, no significant differences were observed for intervention condition or time x intervention condition interaction (Table 23). Post hoc comparisons, showed that the sum of cigarettes consumed significantly decreased in percentage from pre-intervention to 1-month post-intervention, with a percentage decrease of 27% (p = .001) and from pre-intervention to 6-months post-intervention with a percentage decrease of 60% (p = .012). Bonferroni corrections were applied revealing the comparisons between pre-intervention and 1-month remained significant with the corrected alpha of p =.008.

8.4.7 Smoking Cognitions

Measures of smoking cognitions were captured at pre- and all follow up time points (post-, 1-, 3- and 6- months). The cognitions of intentions, attitudes, and SN were identified as non-parametric. Therefore, medians and the range of raw scores and percentage change from pre-intervention are outlined for the whole sample (total) and instruction conditions (Neutral/Reassuring), across follow up time points (Table 24).

Table 24 *Smoking cognitions (intentions, attitudes and subjective norms), descriptive data across follow-up time points and between conditions, within the pilot.*

	Raw score *Mdn (Rng)*			% Change *Mdn (Rng)*		
Cognition	Intentions	Attitudes	SN	Intentions	Attitudes	SN
pre-						
Neutral	11.6 (7.7)	10.5 (6.3)	1.7 (8.0)	-	-	-
Reassuring	12.0 (8.7)	11.0 (9.0)	1.7 (4.0)	-	-	-
Total	11.8 (8.7)	10.9 (9.0)	1.7 (8.0)	-	-	-
post-						
Neutral	11.0 (9.0)	11.8 (10.0)	1.0 (4.3)	0 (62)	0 (97)	0 (122)
Reassuring	12.3 (12.0)	12.5 (6.0)	1.0 (1.0)	2 (112)	4 (237)	-17 (80)
Total	12.2 (12.0)	12.3 (10.0)	1.0 (4.3)	0 (112)	4 (289)	-9 (1220
1-						
Neutral	12.8 (3.3)	11.6 (6.0)	1.0 (6.7)	6 (37)	6 (39)	-6 (236)
Reassuring	12.7 (12.0)	12.1 (11.3)	1.0 (2.0)	1 (112)	0 (309)	-9 (80)
Total	12.8 (12.0)	11.9 (11.3)	1.0 (6.7)	4 (112)	4 (309)	-6 (236)
3-						
Neutral	12.0 (8.7)	10.5 (11.3)	1.0 (12.0)	5 (144)	0 (131)	0 (76)
Reassuring	12.7 (12.0)	11.5 (6.0)	1.0 (3.0)	0 (119)	2 (240)	0 (130)
Total	12.3 (12.0)	11.0 (11.3)	1.0 (12.0)	0 (174)	0 (308)	0 (130)
6-						
Neutral	13.0 (5.0)	12.5 (5.5)	1.0 (9.3)	8 (48)	4 (37)	0 (237)
Reassuring	13.0 (12.0)	12.8 (6.0)	2.8 (4.00	0 (88)	13 (219)	0 (480)
Total	13.0 (12)	12.5 (6.0)	1. (9.3)	0 (114)	6 (219)	0 (480)

Note: % = change from pre-intervention. SN = subjective norms, [-] = no measurement obtained. pre- (N = 30 (Neutral 15, Reassuring 15), 1-month (n = 26 (Neutral 12, Reassuring 14), 3-months (n = 27 (Neutral 13, Reassuring 14), 6-months (n = 19 (Neutral 11, Reassuring 8), Mdn = Median, Rng = Range.

Smoking cognition variables outlined above were entered into non-parametric assessment of the repeated measures, in order to infer the effect of time of measurement on scores (Table 25).

Table 25 *Summary table of Freidman's non-parametric repeated measures comparisons across follow up time points for smoking cognition measurements within the pilot.*

Cognition	*Raw score*			*% Change*		
	X^2	*p*	*W*	X^2	*p*	*W*
Intentions	7.57	.109	.11	7.57	.109	.11
Attitudes	13.14	.011	.18	13.14	.011	.18
SN	15.81	.003	.22	15.81	.003	.22

Note: n = 19, degrees of freedom (df)= 4. % = percentage change from pre-intervention

No significant effect of time of measurement could be observed for measures of intentions. A significant effect of time of measurement could be observed for measures of smoking attitudes (Table 25). Post hoc pairwise comparisons indicated significant increases in attitudes from pre-intervention to post-intervention (Z = -1.14, p = .031) and pre-intervention to 6-months post-intervention *(*Z = -1.44, p = .006). Comparisons did not remain significant when Bonferroni corrections with the corrected alpha (p =.005) was applied.

The percentage change in attitudes from pre-intervention to follow up time points also displayed a significant effect of time (Table 25). Post hoc pairwise comparisons were carried out revealing significant increases from pre-intervention to post-intervention (Z= -2.78, p = .005) and pre-intervention to 6-months post-intervention (Z= -2.90, p = .005). Comparisons remained significant when Bonferroni corrections with the corrected alpha (p =.005) was applied.

Scores of SN also displayed a significant effect of follow up time point (Table 25). Post hoc comparisons revealed no significant differences between pre- and post-intervention time points. The percentage change of SN from pre-intervention to post-intervention time points displayed a significant main effect of time (Table 25). Post hoc pairwise comparisons were carried out revealing significant decreases from pre-intervention to post-intervention (Z= 1.14, p = .019. Comparisons did not remain significant when Bonferroni corrections with the corrected alpha (p = .005) was applied.

Between groups comparison took the form of comparison between instruction conditions at each time of measurement, for both raw scores and percentage change cognition variables (Table 26). No significant differences could be observed between instruction conditions for scores of intentions, attitudes and SN (Table 26).

Table 26 *Summary table of Mann-Whitney U independent samples post hoc tests for between instruction conditions of smoking cognition measures, within the pilot*

Time of measurement	Raw score		% Change	
	U	*p*	*U*	*p*
Intentions				
Post-intervention	150.0	.126	124.5	.624
1-month	78.0	.781	60.0	.231
3-months	93.0	.943	58.5	.116
6-months	47.0	.840	24.5	.109
Attitudes				
Post-intervention	129.0	.485	129.0	.512
1-month	84.0	1.0	57.5	.176
3-months	104.0	.550	101.5	.616
6-months	47.0	.840	52.0	.545
SN				
Post-intervention	97.5	.539	97.5	.539
1-month	81.0	.899	81.0	.899
3-months	87.5	.867	87.5	.867
6-months	75.0	.608	75.0	.608

Note: % = change from pre-intervention. SN = subjective norms, [-] = no measurement obtained. pre- (N = 30 (Neutral 15, Reassuring 15), 1-month (n = 26 (Neutral 12, Reassuring 14), 3-months (n = 27 (Neutral 13, Reassuring 14), 6-months (n = 19 (Neutral 11, Reassuring 8).

The cognition of PBC was identified as parametric. Therefore, means and standard deviations of raw scores and percentage change from pre-intervention to follow up time points are outlined for the whole sample (Total) and instruction conditions (Neutral/Reassuring) (Table 27).

Table 27 *Percieved behavioural control, descriptive data across follow-up time points and between conditions, within the pilot.*

Time of measure	PBC *M* (*SD*)			PBC %		
	Neutral	Reassuring	Total	Neutral	Reassuring	Total
pre-	7.7 (1.4)	8.4 (2.0)	8.0 (1.7)	-	-	-
post-	8.3 (1.4)	8.9 (2.1)	8.6 (1.8)	24.5 (25.6)	15.8 (17.7)	20.1 (22.0)
1-month	9.1 (1.3)	8.2 (2.3)	8.6 (1.9)	32.8 (35.1)	1.7 (24.8)	16.04 (33.3)
3-months	9.4 (2.3)	9.1 (2.7)	9.2 (2.5)	22 (34)	33.0 (47.2)	19.1 (42.7)
6-months	9.0 (1.8)	8.8 (2.2)	8.9 (1.9)	29.1 (35.1)	25.0 (81.0)	27.0 (62.0)

Note: %= percentage change from pre-intervention, [-] = no data collected. pre- (N = 30) (Neutral 15, Reassuring 15), 1-month (n = 26 (Neutral 12, Reassuring 14), 3-months (n = 27 (Neutral 13, Reassuring 14), 6-months (n = 19 (Neutral 11, Reassuring 8), M= Mean, SD= Standard deviation.

To assess for effects of time and instruction condition on measures of PBC, ANOVA repeated measures analysis was conducted for the raw scores across follow up time points and the percentage change from pre-intervention to follow up time points (Sphericity not assumed, Greenhouse-Geisser corrections applied) (Table 28).

Table 28 *Summary table representing ANOVA repeated measures results for PBC across follow up time points and between conditions, within the pilot.*

Measure	Simple main effect of time within group				Between subjects effect of time				Interaction time*instruction			
	F	*df*	*p*	ηp^2	*F*	*df*	*p*	ηp^2	*F*	*df*	*p*	ηp^2
PBC	3.01	2.73, 51.881	.043	.14	1.36	1,19	.258	.07	1.15	2.73, 51.881	.335	.06
PBC %	2.34	1.742, 33.090	.119	.11	1.54	1,19	.230	.08	.56	1.742, 33.090	.552	.03

Note: PBC = perceived behavioural control, n = 19, %= percentage change from baseline to follow up time points, df = degrees of freedom, ηp^2 *= partial eta squared.*

For scores of PBC a main effect of time was evidenced, no significant differences were observed for intervention condition, or time x intervention condition interaction (Table 28). Post hoc comparisons, showed that scores of PBC significantly increased from pre-intervention to 1-month post-intervention, with a mean increase of 1.27 (p = .001). Which did remain significant after applying Bonferroni corrections (corrected alpha p = .005).

For PBC percentage change a main effect of time was evidenced, no significant differences were observed for intervention condition or time x intervention condition interaction (Table 28). Post hoc comparisons, showed that PBC scores significantly decreased in percentage from pre-intervention to 1-month post-intervention, with a percentage increase of 19% (p = .003) and pre-intervention to 6-months post-intervention, with a percentage increase of 32% (p = .038). Bonferroni corrections were applied revealing that the comparisons between pre-intervention and 1-month post-intervention did not remain significant with the corrected alpha (corrected alpha p = .005).

8.5 Discussion

Quantitative analysis achieved the aims set out for the development of research protocol, investigation of the stress response and exploration of smoking outcomes. Information regarding the stress response, the impact of the age-progression intervention protocol on the retention of participants and efficacy of the intervention was gathered. Results from this quantitative based investigation combined with those gathered from qualitative means were used to inform the design and procedure of the RCT investigation.

8.5.1 Summary of findings.

A first aim of the pilot research was to assess if the intervention elicited a stress response. Within the whole sample an increase in all measures of physiological stress was observed from Baseline to morphing phases and in subjective stress from pre- to post-intervention. This indicated that the age-progression intervention increased stress in the current sample. Two instruction types were designed and introduced within this pilot investigation, in order to be tested for the introduction in later RCT research. Instructions were designed in order to manipulate the levels of stress experienced by the participant during administration of the age-progression intervention. Instruction content was devised to either maintain (Neutral instructions) or decrease (Reassuring instructions) the levels of stress induced via the age-progression intervention. The current pilot study investigated if the instruction types induced differing levels of stress response, as intended. The results suggest that differences in EDA could be observed between instruction type within the last morphing phase of the intervention (Morph3D_R). The Reassuring condition exhibiting an increased response in comparison to Neutral condition. Consequently, it was evidenced that the instruction conditions designed induced differing levels in the physiological stress response. Findings from both subjective stress and physiological response echo the accounts of "shock reaction" presented in Chapter 7, which is more elevated in participants delivered reassuring instructions.

The second aim was to explore the feasibility of the data collection plan, achieved through the monitoring of recruitment and retention throughout the research protocol. The attrition of participants was assessed at 1-, 3- and 6- months follow up data collection points, in order to estimate the level of drop out that could be anticipated for later research. Drop out at 1- and 3-months follow up remained at a minimum with only 10% drop out of participants at 3-months. A larger amount of attrition (36%) was observed at 6-months post-intervention.

Lastly, the pilot aimed to explore if smoking behaviour and smoking cognitions were positively changed from pre- to post-intervention time points. A significant positive change in the sum of cigarettes consumed, quit smoking attitudes and perceived behavioural control over smoking behaviour was observed from pre-intervention to post-intervention time points. The results therefore suggest the intervention may have contributed to the participants decrease in the amount smoked during that time and increase in cognitions relating to smoking cessation. As a pilot, no control comparison was made in this study, therefore conclusions with regards to efficacy of the intervention cannot be drawn from these

findings. However, the information gained from this exploratory analysis of the intervention efficacy gave direction for the subsequent RCT investigation, giving indication to continue in the measurement of both smoking cognitions and behaviour.

8.5.2 Discussion of results

The current study evidenced how the age-progression intervention increased levels of stress in the current sample of women. Qualitative analyses of reports obtained from the same set of participants presented in Chapter 7, in addition to those reported in previous research with women (Grogan et al., 2010b) and men (Flett et al., 2017), indicated that participants were shocked by the morphed images displayed by the intervention. When combined, the current pilot results suggest that a stress reaction may be related to the 'shock reaction' experienced by the participants. When looking at differences in this stress response between the instruction types, small differences were observed where the Reassuring instruction condition displayed increased levels of EDA, in comparison to the Neutral instruction condition. This between subjects effect was diminished with the use of corrected alpha. However, the use of alpha corrections is problematic within small samples as it reduces the level of power which was already low due to sample size (Moran, 2003; Nakagawa, 2004). Taking into consideration the exploratory nature of the analyses, and small sample size, the findings should be considered with caution. Although the results are not in the intended direction (it was expected that the reassuring instructions would reduce the stress reaction to the images), as the increase in the stress response elicited by the Reassuring condition seem to align in the same direction inferred within the qualitative findings, some confidence can be placed in the findings. Still, manipulation of the stress response, in the sense of one instruction increased in levels of stress in comparison to the other, was observed. Therefore, the aim of the pilot study was achieved and the same instructions were used in the full investigation of the impact of the instruction types in the RCT investigation (Chapter 9).

To the authors knowledge the current research is the first to date to measure the subjective stress response and physiological reactivity in response to an appearance-based intervention and assess its impact on the efficacy of the intervention. In a similar manner, previous researchers have investigated the emotional effects of graphic health warnings on smoking outcomes. Wang et al. (2015) asked twenty-four smokers to view graphic warnings used on cigarette packages, rated as either high or low in emotional reactivity. Warnings rated as high in emotional reactivity were better remembered by participants and were associated with a greater reduction in urge to smoke. High emotional reaction labels also increased brain activation in the amygdala, and other related areas, as measured by functional magnetic

resonance imaging (fMRI), suggesting that activation of the amygdala during stimulus processing may modulate the encoding and consolidation of memory (Wang et al., 2015). As the amygdala is activated during stress (Phan et al., 2002; Ressler, 2010), it could be expected that the increase of the subjective stress and physiological arousal induced by the age-progression intervention could improve consolidation of the intervention imagery, and in turn, reduce smoking behaviour. Further research on the impact of the instruction type differences can help to establish the optimal level of stress needed for effective behaviour change.

As expected, a larger amount of attrition (37%) was observed at 6-months post-intervention. In a systematic review of smoking cessation intervention studies including pharmacological, educational or behavioural interventions published between 1980 and 2015 results indicated attrition ranged from 11% to 77% (Belita and Sidani, 2015). Although an acceptable level of attrition as to not bias intent to treat imputation has not been widely agreed, within the investigation of drugs or therapies, an attrition of > 20% is often used to define the research as "low-quality" (Fewtrell et al., 2008). In the pilot study, the small-scale experiment of thirty participants, attrition levels remained within recommended levels for the 1- and 3-months follow up, yet findings from 6-month follow up should be considered with caution given the increase in attrition rate.

The longer time in contact between the researcher and participant could have contributed to the greater loss in participants at 6-months (note that 2 months elapsed between the follow ups at 1- and 3-months; while 3-months without contact was the interval between 3- and 6-months follow ups), indicating that increasing the instances of contact with participants could have prevented drop outs. However, increasing contact could also interfere with the study outcomes. For example, adding more contact could result in measurement reactivity (French and Sutton, 2010), which has been described by researchers as when individuals alter their behaviour due to the awareness of being observed. In the current pilot investigation, participants could have been reminded of their current smoking behaviour and cognitions and therefore prompted to monitor or change their behaviour. Previous research reported that smokers who completed measures on multiple occasions were more likely to respond with higher motivation to quit than those assessed only twice (DiClemente et al., 1991; Hughes et al., 2005). Longitudinal studies need to consider carefully the advantages and disadvantages of increasing contact with participants in order to prevent dropouts while minimising the effect of the contact on the research outcomes.

The results regarding attrition and follow up data were taken into account for the subsequent RCT investigation. Sample size calculations were increased by 20% to account for loss to follow up and minimise bias in results and quality of research. In addition, decisions were made to maintain the same level of contact with participants as in the pilot study to minimise measurement reactivity. On the other hand, steps to reduce drop out at follow up time points (e.g., reminder emails), were implemented in the RCT study. Consequently, the modelling of attrition throughout this pilot investigation informed the design of the following RCT, in order to optimise retention of participants across the 6-months of follow ups.

Previous research investigating the efficacy of the intervention showed that in comparison to a control condition, participants that receive the age-progression intervention had i) lower smoking rates four-weeks post-intervention (Grogan et al., 2011), and ii) higher quit smoking rates at 6-months post-intervention (Burford et al., 2013). The current research evidenced a reduction in smoking behaviour in the whole sample 3-months post-intervention, supporting previous findings. Additionally, as in previous research (Grogan et al., 2011), an effect of the intervention was observed on both quit smoking attitudes and PBC. In the pilot study reported here, the effect remained up to 6-months post-intervention for levels of attitudes rather than the measured 4-weeks in Grogan et al. (2011), demonstrating longitudinal impact of the intervention on these measures which has not observed before. As mentioned above, the isolated effect of the intervention could not be inferred given the lack of a control comparison, yet the differences between instruction conditions, although observed in a small sample, indicate that the intervention instruction types have different effects on smoking outcomes, yet conclusions as to the direction of this effect cannot be drawn. The procedure trialled within this pilot study was implemented in the RCT design, enabling the investigation of the intervention effect in a larger sample. Longitudinal research investigating the effects of an age-progression intervention at long-term is still scarce (e.g., (Burford et al., 2013). Hence, research of this type is needed to aid our understanding, confirm preliminary findings and further develop age-progression techniques.

8.5.3 Limitations

There are several limitations of the current study. This study was designed as a pilot study aimed to test some of the specific design aspects of the later RCT investigation. As a pilot study, only a small sample size of participants was required, and a control condition was not included as the aim of the study was not to investigate the efficacy of the intervention.

Therefore, the exploratory findings presented in this chapter should be interpreted with caution.

In addition, block recruitment was employed within the current research in order for protocol development to take place. These developments resulted in slight protocol changes for each block which could have impacted on smoking outcomes. One of the main aims of the present pilot study was to assess how the protocol could be improved and developed, for implementation in the RCT. The block protocol was therefore a vital component of the research design to strengthen the protocol of the RCT.

8.5.4 Conclusion.

The pilot investigation of the age-progression intervention for smoking cessation presented within this chapter indicated that attrition of participants remained at a low level up to 3-months post-intervention, increasing to larger numbers at 6-months. The study assessed the level of subjective and physiological stress participants experienced during the intervention. Demonstrating the intervention elicited an increase in the stress response and moderate differences could be observed between instruction type conditions. Results indicate that compared to Neutral condition, the participants in the Reassuring condition exhibited a higher stress response. Therefore, results indicate instruction conditions induced differing levels of stress, and therefore were implemented in the subsequent RCT, that aimed to investigate the efficacy of the age-progression intervention and the impact of stress elicited by the intervention on smoking outcomes. Furthermore, the results indicate that the present protocol is feasible in terms of recruitment and retention and further procedures for management of attrition in a larger RCT investigation was discussed. Lastly, exploratory analysis indicated changes in smoking behaviour and cognition were observed from pre- to post-intervention, results indicate that smoking behaviour was reduced up to 3-months post-intervention. Confirmation of the effects of the intervention compared to a control condition is needed and was achieved in larger scale research (RCT study, Chapter 9).

8.6 Chapter summary

The present chapter outlines quantitative aspects of a pilot investigation of the age-progression intervention for smoking cessation, testing procedures and feasibility of the research design. Thirty women between the ages of 18-55 were recruited and block randomised to receive one of the two devised instruction conditions, used to deliver the intervention. The results regarding stress, attrition and smoking outcomes are detailed. Lastly, results are discussed in relation to the pilot study aims. The pilot study was successful

in testing all aspects of the research design. Procedure changes and recommendations were adopted for the final empirical chapter of this thesis (Chapter 9).

9 Chapter 9: Randomised Controlled Trial

9.1 Introduction

The final study of this thesis was a Randomised Controlled Trial (RCT) designed to examine the efficacy of an age-progression intervention via two different instructions, compared to an active Control intervention. Previous pilot research within this thesis has trialled the implementation of two instruction type conditions, designed to manipulate the stress response of participants during the intervention delivery. Results in the pilot study indicated that participants administered the Reassuring instructions had an increased physiological and subjective stress and shock response during the intervention delivery, in comparison to the Neutral instruction. The current RCT investigation aimed to assess the impact of the age-progression intervention and control arms on smoking outcomes and investigate the levels of stress elicited by each arm. Additionally, the RCT aimed to asses if this stress response impacted the intervention efficacy. Consequently, the current investigation surpasses previous RCT research on age-progression interventions, by adding a third trial arm. Comparison are made between the two different intervention instructions and the Control arm, in order to investigate the efficacy of the intervention and the impact of the stress response to the intervention. Participants were 72 women between the ages 18-54. This chapter outlines the study design, implementation of intervention arms, results and impact of the study. The study produced experimental research into the effectiveness of age-progression interventions for smoking cessation and investigated alternate delivery of the intervention to increase its effectiveness. The investigation aids our understanding of the impact of stress experienced during the intervention delivery on smoking outcomes. Therefore, the research uniquely contributes to existing knowledge regarding smoking cessation and age-progression intervention techniques.

9.2 Background

As previously indicated, smoking is a major cause of illness, death (Office for National Statistics, 2019) and productivity loss resulting in high cost to the economy (Ekpu and Brown, 2015). Women are also evidenced to have specific health risks beyond males (Huxley and Woodward, 2011) and have increased difficulty in reducing smoking due to a range of factors, including but not limited to increased attenuation of the stress response (al'Absi, 2006) or socioeconomic status (Hosseinpoor et al., 2012). The UK Department for Health has set a goal for a smoke free generation with aims to reduce prevalence of smoking to only 12% of the population by 2022 (Department of Health UK, 2017) and a smoke free generation by 2030 (Office for National Statistics, 2020). It is therefore evident that the UK is in its final difficult stage of achieving smoking cessation within the population. To support

this goal and the needs of women, the development of effective smoking interventions needs to continue. Thus, work to enhance the effectiveness of age-progression interventions previously indicated to be effective in reducing smoking in women can serve to aid this goal.

In Chapter 3, the current evidence for both appearance-based and specifically age-progression interventions was reviewed. Briefly, it was concluded that facial wrinkling age-progression interventions impact positively on smoking behaviour and cognitions, and the overall research quality was rated as moderate (see systematic review Chapter 3). Specifically, RCT evidence has previously found that the intervention (n = 35) increased quit smoking intentions in women in comparison to a control intervention (n = 35) when set in a quit smoking support service within the UK (Grogan et al., 2011). The number of participants reporting thirty-day abstinence from smoking was also found to be higher (both, in men and women, n = 80) compared to the control (n = 80, standard pharmacy advice), when administered in a community setting within Australia (Burford et al., 2013). Therefore, the current evidence, based on robust RCT methodological designs, indicates that age-progression interventions for smoking cessation have been effective when introduced in different settings.

Despite the positive evidence regarding interventions of this type, limitations within previous research have been highlighted and guidance provided on how to strengthen the rigour of future research (Chapter 3). Most of the research recruited only young adult participants, despite evidence to suggest older women respond positively to age-progression type interventions for different health behaviours (Persson et al., 2018a). Lastly, differences were suggested to be shown regarding the time spent with the researcher, between control and intervention within both RCT studies (Grogan et al., 2011; Burford et al., 2013). Participants who received the interventions in both studies, had considerably more face to face contact with the researcher or health practitioner. The time difference between interventions could have had a potential confounding effect on the results (Ockene et al., 1991).

Previous qualitative research (Grogan et al., 2010b; Flett et al., 2017) discussed in earlier chapters (Chapters 3 and 7) has indicated participants were shocked by the aged images viewed during the intervention. This finding led to the conception of this research thesis project, and the development of a pilot study that expanded on previous qualitative findings and established that the intervention increased the physiological and subjective stress and shock response in the participants (Chapters 6 and 7). Furthermore, by administering

Reassuring instructions both the physiological and shock response was increased in comparison to those who received the intervention delivered with Neutral instructions. Theory and research indicate that stress could positively influence behaviour change (Tannenbaum et al., 2015; Droulers et al., 2017), yet little research has investigated the optimal level of stress in relation to the intervention delivery.

Methodological issues identified in previous chapters, and findings that suggest that implemented instruction types create differences in stress in response to the age-progression intervention, provides a strong rationale for the development of the current RCT. The present study adds understanding to these pre-identified gaps in the knowledge and provides additional evidence in support to the efficacy of the intervention.

9.2.1 The current study

The RCT reported in this chapter is a crucial addition to previous research, as it addressed the limitations and concerns raised in relation to the existing literature outlined in Chapter 3. The current study therefore aimed to quantitatively investigate the impact of the age-progression intervention arms (Neutral and Reassuring) and Control intervention arm on smoking outcomes.

The study integrates and builds on previous findings outlined in this thesis, and from previous research. Therefore, following from prior pilot research, the study examined the implementation of two intervention instructions (Neutral and Reassuring) administered with the age-progression intervention. The Reassuring instructions demonstrated a greater increase of stress (both, physiological stress response and subjective stress) in comparison to Neutral instructions. Through implementing the instruction types, the impact of two different intensity levels of stress elicited in response to the intervention can be inferred for its impact on the intervention outcome measures. These results were viewed in comparison to the effects of a control intervention.

Furthermore, in addition to the direct influence of the instruction type, the RCT also aimed to investigate the effects of the stress response, how it differed between intervention arms and how the response either moderated or mediated the behavioural outcomes. In addition to the impact of stress, the research also aimed to study the potential moderating and mediating impact of confounding variables (such as; anxiety, depression and appearance orientation) on the intervention efficacy, that have been identified in previous chapters (Chapter 2 and 3) to impact on smoking cessation attempts in women.

The current research contributes to and expands on previous literature, achieving the overall aim of the thesis. This is attained by investigating the impact of the stress response on the success of the age-progression intervention and providing improvements to study design. This RCT study included the development of a third arm and comparable control intervention, that have previously been overlooked by past research.

9.2.2 Hypothesis

A number of directional and non-directional hypotheses were developed for the primary (intentions) and secondary (attitudes, PBC, SN, sum of cigarettes) outcome variables of the current research.

H1: The intervention arms (irrespective of instruction type) will have significantly higher levels of quit smoking intentions in comparison to the Control intervention at follow up time point intervals.

H2: The intervention arms (irrespective of instruction type) will have significantly higher levels of subjective and physiological stress in response to the intervention arms in comparison with the Control intervention. Additionally, there will be significant differences in the stress response between intervention instruction types, whereby participants in the Reassuring instruction arm will display increased levels of stress in comparison with the Neutral and Control arms.

Exploratory analysis will also be performed whereby the potentially mediating and moderating variables will be entered into regression-based models, to investigate their corresponding impact on smoking outcomes.

9.3 Method

The Consolidated Standards of Reporting Trials (CONSORT) guidelines were adhered for the design and reporting of the RCT (Moher et al., 2010) (CONSORT checklist, Appendix 7). The protocol and analysis strategy was developed prior to the RCT data collection and published on clinicaltrials.gov, (Record: NCT03749382).

9.3.1 Design

The study implemented a pragmatic, three-arm parallel group randomised controlled trial. The design included two active intervention arms (intervention Neutral and intervention

Reassuring). The comparison Control arm included a control task. All the arms included a stop smoking leaflet. Participants were checked for eligibility, randomised to receive one of the three intervention arms and corresponding research protocols, with the measurement of the stress response (subjective stress, EDA and HR). All participants completed a pre- and post-intervention, and follow up questionnaires at 1-, 3- and 6-months post-intervention. Full details regarding the design, protocols, measurement of stress and questionnaires can be found in Chapter 5 (sections: 5.51 for materials, 5.5.2 stress measures, 5.5.4 questionnaires, 5.6.3 sample, 5.7.2 procedure).

Below provides a summary of the outcomes of the RCT and corresponding measures, while Fig. 30 displays a flow diagram of recruitment and attrition.

9.3.2 Outcome measures

A number of outcomes important to the research were planned, measured and analysed during this study. The majority of variables were measured using a self-report questionnaire portfolio administered at varying time points, additionally physiological stress variables were measured during intervention. Below, brief information is provided for each outcome and the measures used. For more detail regarding the implementation and content of each measure, see the methodology chapter (Chapter 5).

9.3.2.1 Primary outcome

The primary outcome (i.e., the primary dependant variable) of the current research was quit smoking intentions, measured via a sub-scale of intentions based on Ajzen's theory of planned behaviour (Ajzen, 1991). For replicability of findings, the questionnaire used by Grogan et al. (2011) was used to measure intention to quit.

9.3.2.2 Secondary outcomes

Secondary outcomes (secondary dependant variables) included other smoking cognitions (Attitudes, PBC and SN) measured via other sub-scales based on Ajzen's theory of planned behaviour (Ajzen, 1991). In addition to smoking cognitions, the sum of cigarettes was included as a secondary behaviour measure as in the pilot. The sum of cigarettes consisted of the sum of self-reported smoking behaviour on each day of the week prior to testing. Further binary outcome measures were obtained, that add to our understanding of the intervention on smoking behaviours. These measures include quit attempts and periods of abstinence, which are indicative of smoking cessation at a later date.

9.3.2.3 Stress outcome variables

Stress was measured pre-, during and post-intervention (please, refer to the methodology Chapter 5, section 5.5.2 for details). Physiological variables of electrodermal activity (EDA) (including measures of EDA Tonic and EDA Amp) and heart rate (HR), was measured at pre-intervention resting period (Baseline) and throughout phases of the age-progression intervention and control pictures.

Subjective stress was measured via a 5-point Likert scale, designed for the current research. Measures were obtained pre-intervention, at the end of the intervention, and after a stop smoking leaflet administration.

9.3.2.4 Potential confounding variables.

Additional variables that were suspected to have influence on the effect of the intervention on smoking outcomes was assessed. These factors included levels of anxiety and depression (as measured by the Hospital Anxiety and Depression scale by Zigmond and Snaith, (1983)). Perceived stress (as measured by the Perceived Stress Scale by Cohen et al., (1994)). Appearance evaluation and Appearance orientation (as measured through subscales of the MBSRQ developed by Cash (2016). Lastly weight concern (measured by the Weight Gain Concern scale by Borrelli and Mermelstein, (1998)).

9.3.3 Sample characteristics

The final sample size included 72 female participants. The number of participants recruited reached just under half of the required sample. Post-hoc power calculation (Faul et al., 2007) of the primary outcome variable for a sample size $N = 72$ showed an effect size = .36, the alpha level is calculated at approximately $\alpha = .76$, indicating the required level of power of $\alpha = .80$ was closely met for the primary outcome analysis.

The mean age of participants was 25.7 ($SD = .9$) with a range of 18-54. The majority of participants were aged under 35 ($n = 64$) despite efforts to recruit participants from a range of backgrounds and ages. Just over half of participants (54%) held a university undergraduate degree and the majority self-classified as white ethnicity (86%) including White British and all other white backgrounds. For more details regarding the participant demographics at pre-intervention please see Table 29, for information on the randomisation process and follow up retention see Fig. 18.

Table 29 *Descriptive data of the sample characteristics at pre-intervention within the RCT.*

Demographic	Control	Neutral	Reassuring	Total
	n = 23	*n* = 27	*n* = 22	*N* = 72
Age M/ SD (min, max)				
Current Age	25.5/1.5 (19, 46)	27.0/1.7 (19, 54)	24.1/1.3 (18, 40)	25.7/7.6 (18, 54)
Age starting smoking	17.8/.6 (15, 26)	17.0/.5 (13, 22)	16.6/.4 (11, 20)	17.1/2.4 (11, 26)
Smoking stage of change (%)				
Pre contemplation	22%	19%	41%	27%
Contemplation	74%	59%	41%	58%
Preparation	4%	22%	18%	15%
Amount usually smoked per a day (%)				
1-5	52%	48%	59%	53%
6-10	26%	41%	32%	33%
11-15	9%	11%	0%	7%
16-20	4%	0%	9%	4%
21-25	9%	0%	0%	3%
Education (%)				
Secondary	0%	0%	5%	1%
Further	30%	15%	13%	20%
Undergraduate	48%	56%	59%	54%
Post-graduate	22%	30%	23%	25%
Employment (%)				
Not working	9%	4%	0%	4%
Part time <15 hours	13%	0%	5%	6%
Part time 15-35 hours	22%	11%	9%	14%
Full time	4%	15%	27%	15%
Student	52%	70%	59%	61%
Ethnicity (%)				
White (English / Welsh / Scottish / Northern Irish / British/ Irish/ Gypsy or Irish Traveller/ Any other White background)	74%	85%	100%	86%
Mixed/Multiple ethnic groups	4%	7%	0%	4%
Asian/Asian British (Indian/Pakistani/Bangladeshi/Chinese/Any other Asian background)	17%	4%	0%	7%
Other ethnic group	4%	4%	0%	3%
Menstrual phase during intervention administration (%)				
Follicular	78%	59%	23%	54%
Luteal	4%	26%	50%	26%
>28	17%	15%	27%	20%
Contraceptive use (%)				
Yes	17%	22%	41%	26%
No	83%	78%	59%	74%

Note: M = Mean, SD = Standard deviation.

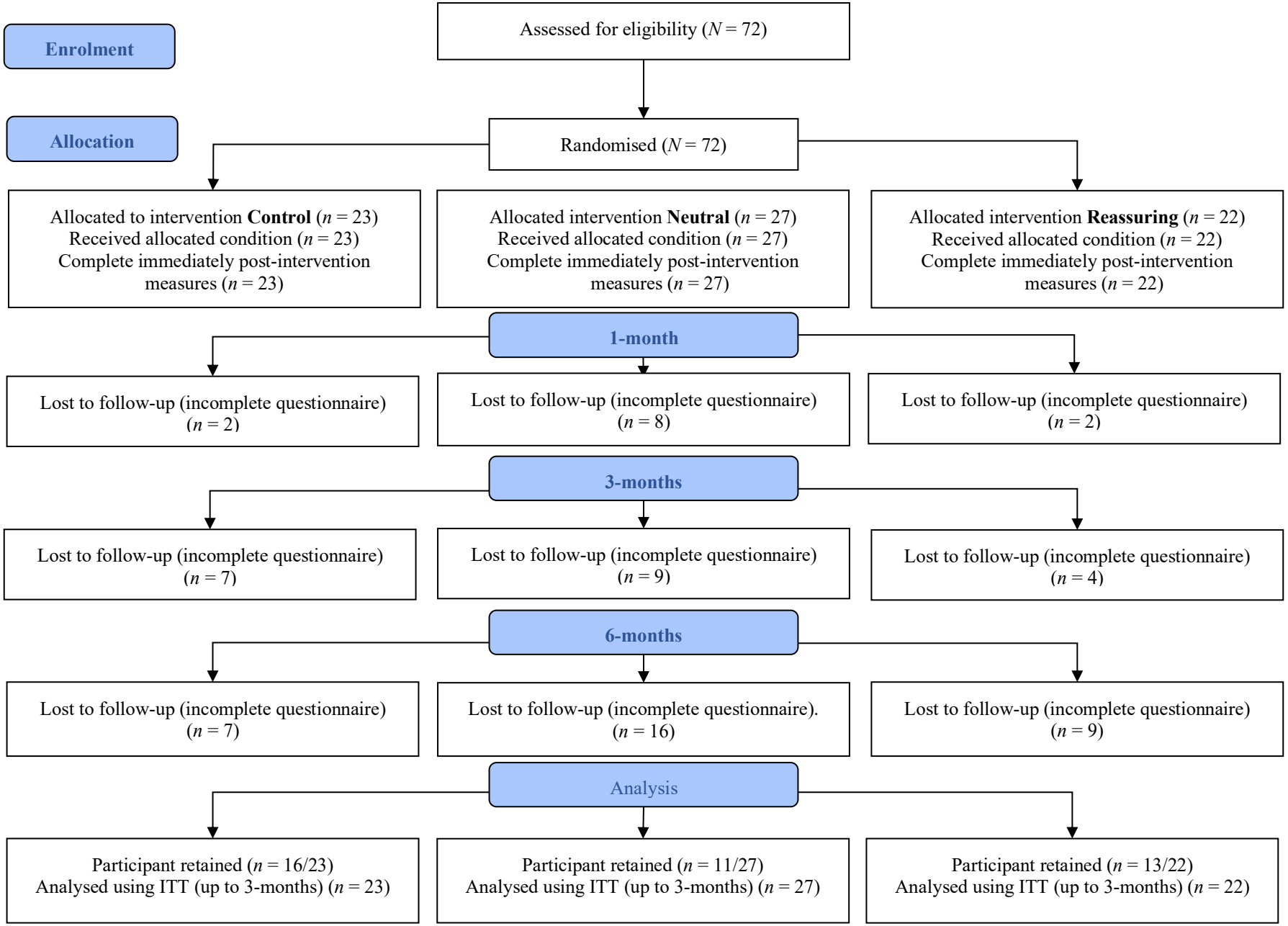

Figure 18 *CONSORT flow chart, displaying the retention of participants within the different arms of the RCT*

9.4 Results

9.4.1 Internal consistency

Internal consistency was assessed for the primary and secondary outcome measures across follow up time points. Presented here is the lowest internal consistency indicated across all follow up time points. The primary outcome quit smoking intentions included three items with alpha levels of above α = .75 for all data collection points. The attitude subscale included four items with a minimum internal consistency score within this study, of α = .74. The measure of PBC included four items, with a minimum internal consistency score of α = 83. The measure of SN was measured using three items and had a minimum internal consistency score of α = .46.

Other scales implemented includes the Hospital Anxiety and Depression scale with a minimum internal consistency of α = .29 that increased to α = .66 for the depression subscale, and a minimum internal consistency of α = .70 across all data collection time points for the anxiety subscale. Perceived Stress Scale at pre-intervention and across follow up time periods with a minimum internal consistency of α = .32 which rose to α = .64 at later time points. Appearance evaluation had an internal consistency of α = .76, while appearance orientation scales, had an internal consistency of α = .87. Lastly Weight Concern scale with an internal consistency of α = .87. Cronbach's alpha scores for all time points presented in Appendix 8.

9.4.2 Data screening

Split by intervention arm, histograms and Q-Q plots were assessed for all outcome variables and stress measurements in relation to visual normality of the data. The majority of measures satisfied assumption tests when visually inspected. Normality was also tested using the Shapiro-Wilk test due to its level of power over other tests such as the Kolmogorov-Smirnov test (Ghasemi and Zahediasl, 2012).

Shapiro-Wilk test analyses were significant for smoking intentions, attitudes and SN. Despite these results the variables were entered into parametric ANCOVA analysis due to the robustness of the test and visual normality of the data (Olejnik and Algina, 1984). Due to the lack of a suitable non-parametric equivalent to the ANCOVA test, non-parametric equivalent tests of one-way ANOVA were calculated for percentage change values from pre-intervention measures to follow up time points. The results were assessed

to determine if inflated significance levels occurred when using parametric tests and corroborate findings from ANCOVA analysis (results reported in Appendix 9).

Boxplots were additionally assessed. Several outliers (i.e., greater than 3 *SD* or below -3 *SD*) were present in the majority of variables. Outliers were checked for errors in data input, participant characteristics, data collection notes and stress confounding variables such as stress experienced prior in the day. Additionally, within measures of subjective and physiological stress, outliers were checked for use medication, time since last caffeine consumption and the presence of any medical condition that could affect measures of the autonomic stress response, or potential artefacts. Outlier participants were not consistent across confounding and stress variables and no other reasons arose for outliers to be removed, therefore the analyses included all the data collected.

For ANCOVA analysis the data entered into the models were checked for homogeneity of variance using the Levene's test. Primary and secondary variables were found to meet assumptions of variance across the data collection time point via non-significant results ($p > .05$). Furthermore, the Mauchly's test of Sphericity was used to test assumptions of sphericity in the data entered into repeated measures ANOVA. If $p > .05$ sphericity was assumed, if sphericity was not assumed ($p < .05$) Greenhouse-Geisser corrections were applied. Further details of the analysis approach can be found in Chapter 5 (section 5.8.2.2).

9.4.3 Baseline variables and equivalence.

A series of one-way ANOVA's were conducted to assess potential significant pre-intervention differences between arms on the outcome variables (primary outcome; intentions and secondary outcomes; attitudes, PBC, SN and sum of cigarettes). The only significant difference occurred for quit smoking intentions, $F(2,1) = 3.73$, $p = .029$. Post hoc comparisons with Bonferroni correction applied (Corrected alpha $p = .016$), indicated that the Reassuring arm had significantly lower quit smoking intentions pre-intervention than the Neutral arm (*M* difference= -1.64, $p = .033$). Information regarding the baseline measures of primary, secondary and moderation/mediation variables and baseline equivalence between arms tests are presented in Table 30.

Table 30 *Summary table of equivalence f tests at pre-intervention between intervention arms, within the RCT.*

Outcome	Control $n = 23$	Neutral $n = 27$	Reassuring $n = 22$	*F (df=2,1)*	η_p^2
Primary outcome variable *M (SD)*					
Intentions	11.4 (1.5)	11.5 (.3)	9.9 (3.3)	3.95*	.10
Secondary outcome variables *M (SD)*					
Attitudes	10.5 (2.2)	10.2 (2.0)	10.0 (.5)	.42	.01
PBC	8.7 (2.9)	7.8 (2.1)	8.1 (2.6)	.84	.02
SN	3.4 (3.1)	2.6 (1.7)	3.3 (2.0)	1.39	.04
Sum of cigarettes	45.4 (39.5)	51.4 (31.7)	45.2 (37.3)	.17	.01
Moderator/Mediator variables *M (SD)*					
PSS	22.8 (5.5)	18.7 (7.6)	21.8 (7.8)	2.37	.06
HADS A	15.1 (3.2)	16.0 (4.0)	14.8 (3.5)	.480	.02
HADS D	5.0 (2.7)	3.9 (3.1)	3.5 (2.9)	1.47	.04
Appearance evaluation	20.6 (6.1)	21.4 (5.6)	19.2 (5.9)	1.04	.03
Appearance orientation	3.6 (.5)	3.3 (.7)	3.7 (.7)	.812	.02

Note: HADS A/D= Hospital Anxiety and Depression scale, Normal 0-7, Borderline case 8-10, Abnormal 11-21. PBC= Perceived behavioural Control, PSS = perceived stress score, SN = Subjective norms.
**, p<0.05 vs Neutral, M = Mean, SD = standard deviation.*

9.4.4 Missing value analysis and imputation

At 1-month post-intervention there was retention of 83% (n = 60/72) of participant responses. The Neutral arm had the highest level of attrition at 30% (n = 19/27) followed by both, the Reassuring (n = 20/22) and Control (n = 21/23) arms, both at 9% attrition. To assess whether data was missing completely at random (MCAR), or due to influence of predictor variables, Little's MCAR test was calculated. The Little's MCAR test indicated that the data was missing at random $X^2 = .10$, $p = .751$. Due to variables being MCAR, missing data at 1-month post-intervention was imputed using the maximum likelihood method, as the level of attrition did not exceed 40%. This allowed for analysis of all N = 72 participants.

At 3-months post-intervention there was retention of 72% (n = 52/72) of participant responses. The Neutral arm had the highest level of attrition at 33% (n = 18/27), followed by the control arm at 30% attrition (n = 16/23) and lastly the Reassuring arm at 19% attrition (n = 18/22). A Chi square test indicated that there was no allocation bias in terms of rates of drop out $X^2(2) = 1.51$, $p = .471$. Little's MCAR test indicated that the data was not MCAR ($X^2 = .00$, $p = .00$). The factor of group allocation can be ruled out as no significant differences in level of attrition could be observed between groups. Therefore, it can be presumed the data was missing at random (MAR) not MCAR. As the level of attrition did not exceed 40% and the data was MAR, data was imputed using the

maximum likelihood method. This allowed for analysis of all $N = 72$ participants at 3-months post-intervention.

Finally, at 6-months post-intervention there was retention of 56% (n = 40/72) of participant responses. The Neutral arm had the highest level of attrition at 56% (n = 11/27), followed by the Reassuring at 41% with (n = 13/22) participants remaining, lastly the Control arm displayed 30% attrition with (n = 16/23) participants remaining. A Chi square test indicated that there was no allocation bias in terms of rates of drop out $X^2(2) = 4.34$, $p = .114$. Imputation of data could not be achieved at 6 months post-intervention due to the level of attrition exceeding 40% which would lead to a decrease in reliability of the imputed responses (Jakobsen et al., 2017). It is worth noting that 30% of the 6-month follow up responses were due to occur after the government ordered a nationwide lockdown for Covid-19, which may have influenced levels of attrition at this time. Appendix 10 reports the proportion of participants who responded and the influence on abstinence at 6 months.

Analysis of binary variables was conducted using only existing data at each follow up time point, due to the non-parametric nature of data of this type, which limits the imputation of accurate data points.

Descriptive data for the primary and secondary outcome measures with imputation are outlined at follow up time points (Table 31).

9.4.5 Primary outcome analysis

To assess the effects of the intervention condition on primary outcome measured at post-intervention, 1-, 3- and 6-months post-intervention, one-way ANCOVA analysis was conducted. Pre-intervention values of the primary outcome were added as covariate to the analysis. Results are presented below in Table 32. Corrections were applied for multiple comparison where between subjects main effects were identified. Bonferroni corrections were applied to post-hoc comparisons reducing the chance of type 1 error occurring.

Table 31 *Primary and secondary smoking outcomes, descriptive data across follow-up time points between intervention arms of the RCT.*

Time point	*n*	Control	*n*	Neutral	*n*	Reassuring
Intentions (*M, SD*)						
pre-intervention	23	11.4 (1.5)	27	11.5 (1.4)	22	9.9 (3.3)
post-intervention	23	11.7 (1.6)	27	11.9 (1.3)	22	10.8 (3.0)
1-month	23	11.4 (1.8)	27	11.4 (1.5)	22	11.1 (2.9)
3-months	23	10.9 (2.2)	27	11.5 (1.1)	22	11.6 (2.1)
6-months	16	10.5 (2.8)	11	11.0 (2.7)	13	11.9 (2.6)
Attitudes (*M, SD*)						
pre-intervention	23	10.5 (2.2)	27	10.2 (2.0)	22	10.0 (.5)
post-intervention	23	11.3 (1.7)	27	10.7 (2.8)	22	10.7 (2.5)
1-month	23	11.4 (1.8)	27	11.4 (1.5)	22	11.1 (2.9)
3-months	23	11.0 (1.7)	27	11.4 (1.5)	22	10.8 (2.6)
6-months	16	11.6 (1.4)	11	10.5 (2.7)	13	12.0 (1.8)
PBC (*M, SD*)						
pre-intervention	23	8.7 (3.0)	27	7.8 (2.1)	22	8.1 (2.6)
post-intervention	23	9.6 (2.5)	27	8.9 (2.3)	22	9.1 (2.8)
1-month	23	9.4 (2.3)	27	8.7 (2.3)	22	8.6 (2.9)
3-months	23	9.5 (2.6)	27	8.2 (2.3)	22	9.1 (2.8)
6-months	16	9.4 (2.6)	11	8.5 (2.2)	13	9.3 (3.3)
SN (*M, SD)*						
pre-intervention	23	3.4 (3.1)	27	2.6 (1.7)	22	3.3 (2.0)
post-intervention	23	2.4 (2.0)	27	2.2 (1.8)	22	2.0 (1.5)
1-month	23	2.1 (1.7)	27	2.4 (2.0)	22	1.6 (1.1)
3-months	23	2.3 (1.9)	27	2.3 (2.0)	22	1.6 (.7)
6-months	16	2.0 (1.9)	11	2.2 (1.9)	13	1.9 (2.4)
Sum of cigarettes (*M, SD*)						
pre-intervention	23	45.4 (39.5)	27	51.4 (31.7)	22	45.2 (37.3)
post-intervention	23	-	27	-	22	-
1-month	23	40.2 (30.7)	27	36.0 (20.0)	22	42.3 (42.3)
3-months	23	33.1 (29.4)	27	32.6 (26.0)	22	31.1 (32.6)
6-months	16	37.7 (37.9)	11	35.8 (25.9)	13	23.0 (33.3)

Note: PBC = perceived behavioural control, SN = subjective norms, [-] = no data collected at this time point, M = Mean, SD = standard deviation.

A between subjects effect of intervention arm was observed on quit smoking intentions at 3-months post-intervention F (1,68) = 4.37, p = .016, η_p^2 =.11, (Table 32), with a medium effect. Post hoc tests indicated there was a significant difference between the Control and Reassuring arms (p = .013). Comparing the estimated marginal means showed that levels of quit smoking intentions were higher in the Reassuring group (M = 12.1) compared to the control (M = 10.7) (Fig. 19).

Table 32 *Summary table representing ANCOVA results for intentions between intervention arms, within the RCT.*

Time point	*F*	*p*	η_p^2
post-intervention	.21	.812	.01
1-month	.60	.551	.02
3-month	4.37	.016	.11
6-month	2.43	.102	.12

Note: degrees of freedom (df) = 1,68, η_p^2=partial eta squared.

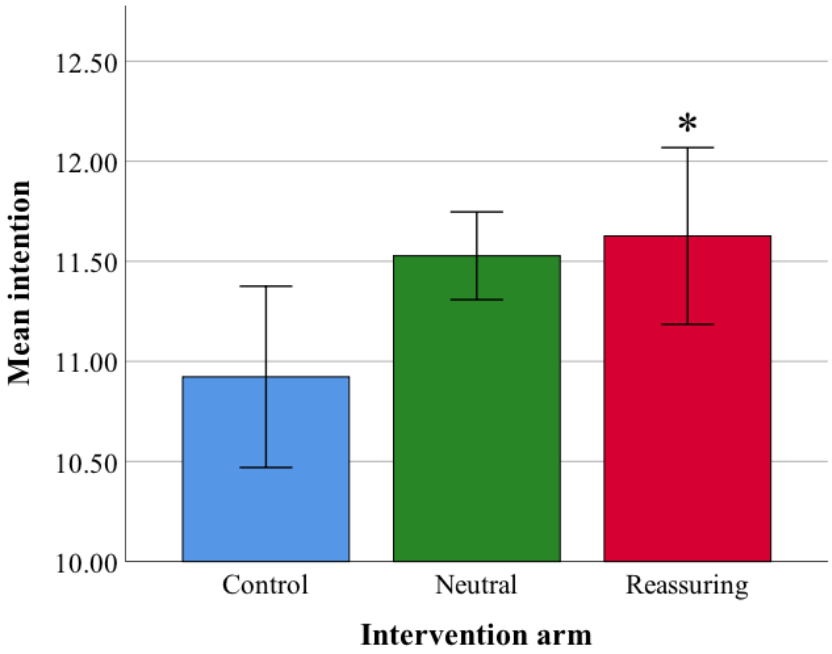

Figure 19 *3-months post-intervention quit smoking intentions between intervention arms.*
Note: Control = Blue bar. Neutral= Green bar, Reassuring = Red bar, Error bars +/- 1 SE
**, p<.05 vs Control*

To further assess the long-term impact of the intervention arm on the primary and outcome measured at follow up time points, exploratory repeated measure ANOVA analysis was conducted on percentage change calculations of the outcomes from pre- to post-intervention time points. Due to the repeated measure analysis *n* = 40 participants were included in the analysis (data not imputed due to percentage change calculation), reflecting the number of participants remaining at 6-months post-intervention delivery with no imputation. Results are found below in Table 33.

Table 33 *Summary table representing ANOVA repeated measures results for Intentions across follow up time points and between intervention arms, within the RCT.*

Outcome	Simple main effect of time within group				Between subjects effect				Interaction time*intervention			
	F	*df*	*p*	ηp^2	*F*	*df*	*p*	ηp^2	*F*	*df*	*p*	ηp^2
Intention	1.61	2.872, 106.275	.193	.04	4.61	2,37	.016	.20	2.05	5.745, 106.275	.068	.10

Note: *df= degrees of freedom, ηp^2=partial eta squared.*

Quit smoking intentions percentage change, displayed a between subjects effect of intervention. Post hoc tests indicated there was a significant difference between the Control and Reassuring intervention arm (p = .021). Comparing the estimated marginal means showed the mean differences in intentions were highest in the Reassuring group (20% increase from Baseline) compared to the Control (2%; Fig. 20). No significant effect of time or time x intervention arm could be observed.

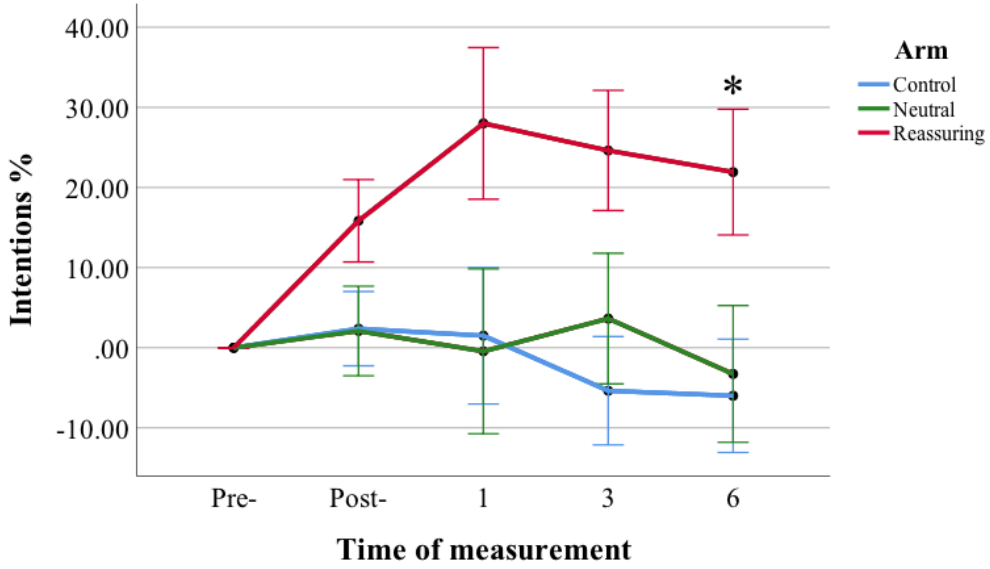

Figure 20 *Quit smoking intentions across follow up time points and between intervention arms of the RCT.*
Note: %= percentage change from pre-intervention, Control= Blue, Neutral= Green, Reassuring= Red, Error bars +/- 1 SE.
**, p<.05 Reassuring vs Control.*

9.4.6 Secondary outcome analysis

Participants levels of CO breath measures correlated positively with measures of self-report sum of cigarettes (r (71) =.60, p <.001) and reported number of cigarettes the 24hrs before testing (r (71) =.67, p <.001), i.e. participants reporting a higher number of cigarettes the past week and 24hrs had higher levels of CO breath readings, indicating that the measure of self-report smoking behaviour is a valid representation of participants smoking habits.

One-way ANCOVA analysis were conducted to assess the effects of the intervention condition on the continuous secondary smoking outcomes measured at post-intervention, 1-, 3- and 6-months post-intervention. Pre-intervention values of the secondary outcomes were added as covariate to the analysis. Results are found below in Table 34. No

significant differences were observed for between intervention arms on the secondary smoking outcomes.

Table 34 *Summary table representing ANCOVA results for secondary smoking outcomes between intervention arms, within the RCT.*

Time of measurement	*F*	*p*	η_p^2
Attitudes			
post-	.20	.822	.01
1	.11	.895	.00
3	.83	.441	.02
6	1.95	.157	.10
PBC			
post-	.09	.917	.00
1	.37	.692	.01
3	1.08	.345	.03
6	.40	.674	.01
SN			
post-	1.77	.178	.05
1	1.91	.155	.05
3	2.00	.144	.06
6	.29	.752	.02
Sum of cigarettes			
1	1.14	.327	.03
3	.16	.854	.01
6	1.94	.159	.10

Note: PBC = perceived behavioural control, SN = subjective norms. degrees of freedom (df) = 1,68, η_p^2 *= partial eta squared*

Chi square tests were used to assess the differences in number of participants who made quit attempts and were abstinent at each follow up time point. Numbers of participants for the presence of a quit attempt varied due to incomplete questionnaires. At 1-month *n* = 58/60 responses were recorded, indicating *n* = 2 incomplete responses (1 Control, 1 Reassuring). Table 35 outlines results.

Table 35 *Summary table of Chi square tests for the binary secondary outcomes between intervention arms across follow up time points of the of the RCT.*

Time points	N	X^2	Control *(n)*	Neutral *(n)*	Reassuring *(n)*
Quit attempt					
1-month	58	9.83*	3/20	11/19	11/19
3- months	52	2.16	7/16	13/19	10/18
6-months	40	1.55	5/15	5/11	7/13
7 day point abstinence					
1-month	60	2.41	1/21	2/19	4/20
3-months	52	2.44	1/16	4/19	5/19
6-months	40	6.37*	0/16	1/11	4/13

Note: df (degrees of freedom) = 2.
**, p<.05*

At 1-month post-intervention there was a significant difference in the presence of a quit attempt (Table 35). Specifically, 15% (n = 3/20) of Control participants reported a quit attempt compared to 58% (n = 11/19) of participants in both the Neutral and Reassuring arms, indicating participants were more likely to make a quit smoking attempt after receiving the age-progression intervention regardless of instruction type (Fig. 21).

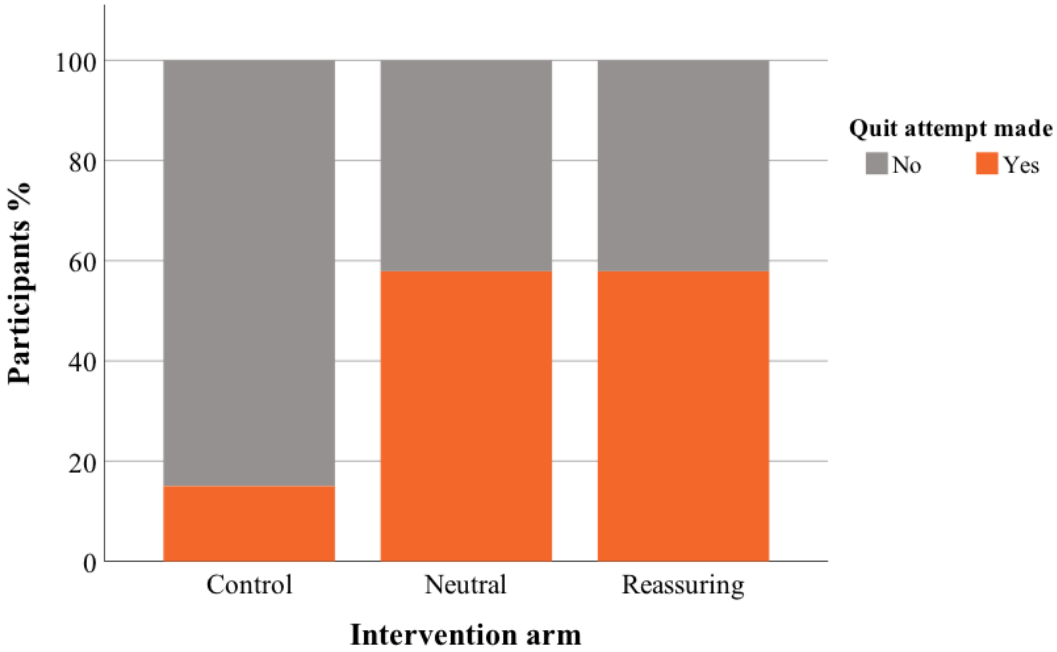

Figure 21 *Percentage of participants who did and did not make a quit attempt at 1-month post-intervention across arms of the RCT.*
Note: Orange = Quit attempt made, Grey = Attempt not made.

At 6-months post-intervention there was a significant difference in the presence of 7 day point abstinence (Table 35). The Control arm participants reported n = 0/16 abstinence, compared to n = 1/11 in the Neutral and lastly n = 4/13 from Reassuring participants. Results indicate participants were more likely to be abstinent at 6-months post-intervention when they received the intervention with Reassuring instructions (Fig. 22).

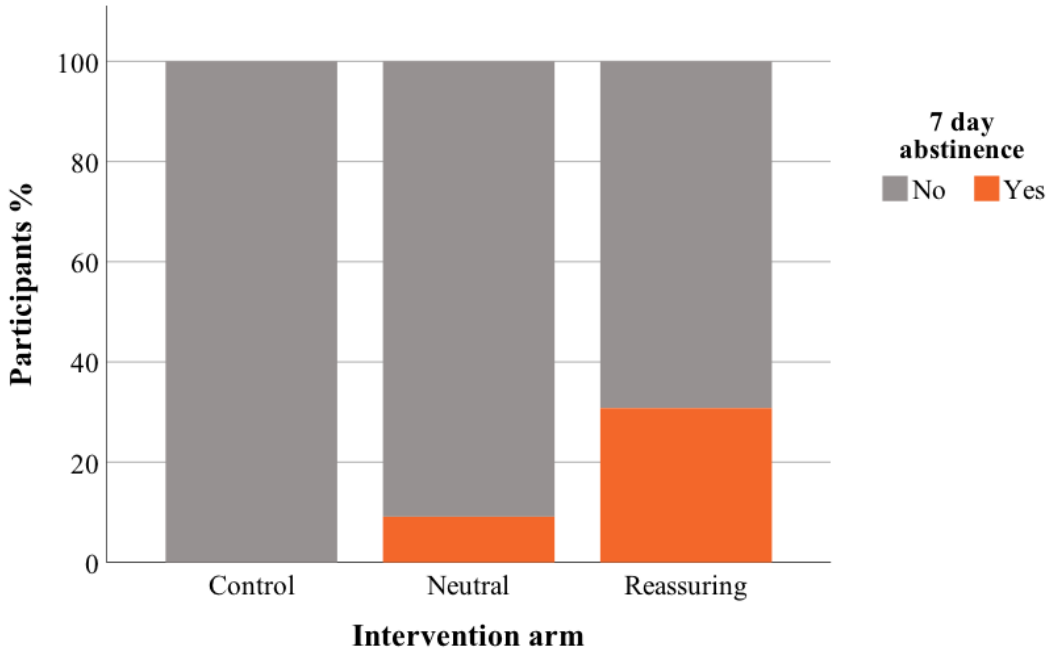

Figure 22 *Percentage of participants who were and were not abstinent for 7 days prior to 6- months post-intervention within the intervention arms of the RCT.*
Note: Orange=Abstinent 7 days prior to follow up completion, Grey= Not abstinent.

To further assess the long-term impact of the intervention arm on the secondary outcomes measured at follow up time points, exploratory repeated measure ANOVA analysis was conducted of the percentage change outcomes from pre- to post-intervention time points, sphericity was not assumed and Greenhouse-Giesser corrections applied. Due to the repeated measure analysis $n = 40$ participants were included in the analysis, reflecting the number of participants remaining at 6-months post-intervention delivery with no imputation. Results are found below in Table 36.

Table 36 *Summary table representing ANOVA repeated measures results for secondary smoking outcomes across follow up time points and between intervention arms, within the RCT.*

Measure	Simple main effect of time within group				Between subjects effect				Interaction time*intervention			
	F	*df*	*p*	ηp^2	*F*	*df*	*p*	ηp^2	*F*	*df*	*p*	ηp^2
Attitudes	4.95	2.961, 121.393	.003	.12	.59	2,37	.561	.03	.61	5.922, 121.393	.720	.03
PBC	2.14	1.844, 86.241	.129	.06	.31	2,37	.738	.02	.42	3.689, 68.241	.781	.02
SN	2.19	1.460, 54.026	.134	.06	3.14	2,37	.055	.15	1.61	2.920, 54.026	.199	.08
Sum of cigarettes	2.81	2.332, 86.281	.058	.071	1.53	2,37	.229	.08	1.32	4.664, 86.281	.265	.07

Note: PBC = perceived behavioural control, SN = subjective norms. df = degrees of freedom, η_p^2 = Partial eta squared.

Results indicate that no significant effect was observed for the percentage change of the continuous secondary smoking outcome measures of PBC, SN and sum of cigarettes from

pre-intervention across measurement time points. And no significant between arm or time x intervention arm interactions could be observed for all measures.

For attitude percentage change a main effect of time was evidenced (Table 36). Post hoc comparisons showed that attitude scores significantly increased in percentage from pre-intervention to immediately post-intervention with a percentage increase of 8% (p = .026), pre-intervention to 1-month post-intervention with a percentage increase of 17% (p = .001). Additionally, from pre-intervention to 3-month post-intervention, with a percentage increase of 11% (p = .044) and pre-intervention to 6-months post-intervention with a percentage increase of 16% (p = .005). Bonferroni corrections were applied, revealing that the comparisons between pre-intervention to 1- and 6-months post-intervention remained significant with a corrected alpha of p =.005.

9.4.6.1 Subjective Stress

To assess the effect of the intervention arm on levels of subjective stress a repeated measures ANOVA including measures of subjective stress at pre-intervention; at the end of the intervention session and after health leaflet delivery was conducted. Sphericity was not assumed and Greenhouse-Giesser corrections applied. Results showed firstly a significant main effect of time of measurement F (1.678,115.806) = 4.47, p = .019, η_p^2 = .06. Post hoc analysis indicates that at the end of the intervention session estimated marginal means of subjective stress were significantly increased compared to after leaflet delivery (M difference = .23, p <.001), which remained significant at the Bonferroni corrected alpha of p =.016.

A between subjects effect of intervention arm was observed F (1,69) = 2, p = .047 η_p^2 = .09, post hoc comparisons indicate that the Reassuring arm had significantly increased overall levels of subjective stress compared to the Control arm (M difference = .397, p = .019), however the difference did not remain significant at the Bonferroni corrected alpha of p =.016.

A significant interaction was also observed between time point of measurement and arm F (1.678,115.806) = 2.63, p = .047 η_p^2 = .07. Post hoc analysis of the simple main effect revealed that at pre-intervention no effect of arm could be observed F (1,69) = .35, p = .707, η_p^2= .01. Similarly, after leaflet delivery no effect of the intervention arm could be observed F (1,69) = 2.30, p = .108 η_p^2 = .06. At the end of the intervention session there was a significant between subjects effect of intervention arm F (1,69) = 5.53, p = .006

η_p^2=.14. Post hoc independent samples comparison tests displayed there was a significant difference between the Control and Reassuring intervention arms (p = .004), which remained significant at the Bonferroni corrected alpha of p =.016. Comparisons in the estimated marginal means showed that subjective stress was highest in the Reassuring group (M difference = 2.77) compared to the Control (M difference = 2.04) at the end of the intervention session (Fig. 23).

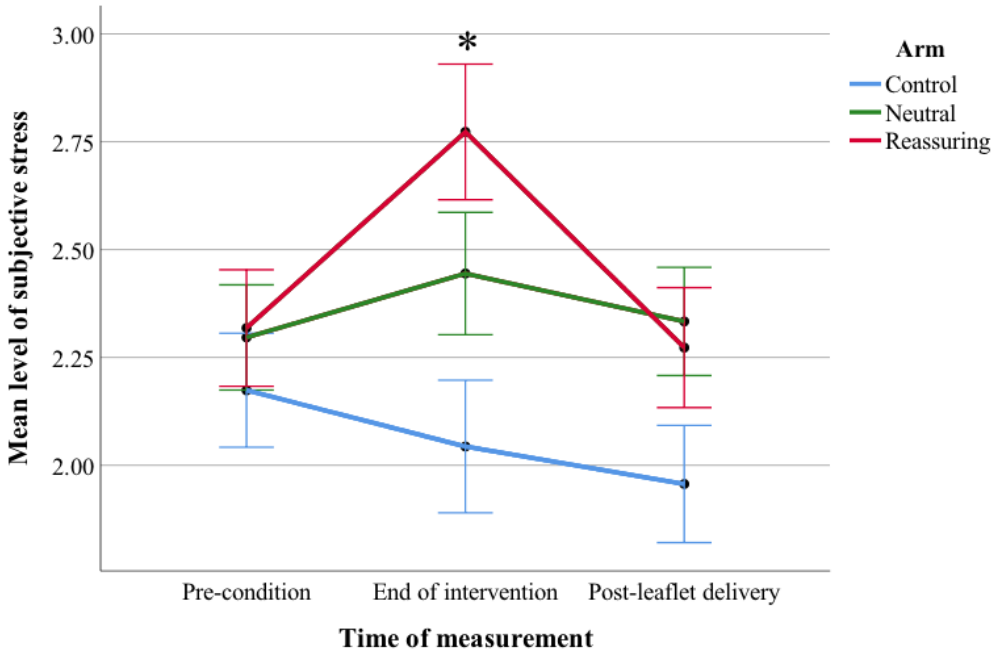

Figure 23 *Line graph of subjective stress across measurement timepoints and arms of the RCT. Note: Control = Blue line, Neutral = Red line, Reassuring = Green line. Error bars +/- 1 SE. *, p<.05 Reassuring vs Control*

9.4.6.2 Physiological Stress

Table 37 summarises means and standard deviations of the physiological measures grouped by arm for all morphing phases of the intervention arms and equivalent picture phase of the Control. The data presented below will be labelled as phases 1-5 which reflects both morphing phases for the age-progression intervention arms and pairs of images for the Control arm. Phase 1 (Morph2D / Pic 1), Phase 2 (Morph2D_R / Pic 2) Phase 3 (Morph2D_R' / Pic 3), Phase 4 (Morph3D / Pic 4), Phase 5 (Morph3D_R / Pic 5). The measure of EDA Amp includes n = 65/72 participants due to a small proportion of participants who did not exhibit any non-specific skin conductance responses, within the predefined morphing or picture phases. All other measures included all N = 72 participants.

Table 37 *Physiological measurement descriptive data across phases between intervention arms of the RCT.*

Phase	EDA Tonic (µS) *M* (*SD*)			EDA Amp (µS) *M* (*SD*)			HR (BPM) *M* (*SD*)		
	C	N	R	C	N	R	C	N	R
Baseline	10.9 (5.3)	9.4 (3.6)	12.2 (7.1)	11.6 (5.7)	10.21 (3.6)	13.4 (7.7)	80.0 (18.4)	72.7 (13.5)	74.2 (12.0)
Phase 1	12.0 (5.6)	11.5 (3.8)	14.1 (8.2)	12.5 (5.7)	11.9 (3.8)	14.7 (8.6)	82.4 (18.7)	77.5 (17.9)	79.7 (12.7)
Phase 2	11.8 (5.3)	11.1 (3.8)	13.5 (7.8)	12.4 (5.6)	11.4 (3.8)	14.0 (8.0)	80.3 (19.3)	77.0 (11.9)	75.7 (14.7)
Phase 3	12.0 (5.5)	11.0 (3.8)	13.6 (8.0)	12.6 (6.0)	11.5 (3.8)	14.1 (8.2)	79.9 (18.4)	74.2 (13.4)	77.7 (13.0)
Phase 4	11.8 (5.4)	10.7 (4.0)	13.3 (7.8)	12.4 (5.8)	11.0 (3.9)	13.9 (7.9)	78.9 (19.6)	75.2 (13.9)	76.2 (13.1)
Phase 5	12.0 (5.5)	10.6 (4.2)	13.3 (8.0)	12.8 (6.0)	11.1 (4.3)	13.7 (8.1)	79.9 (18.4)	74.1 (14.6)	76.8 (11.8)

Note: C= Control, N=Neutral, R= Reassuring, µS= Microsiemens, BPM= Beats Per Minute, EDA Tonic=electrodermal activity tonic measurement, EDA Amp= electrodermal activity mean amplitude measurement. HR= Heart Rate measured via BPM. M=Mean, SD= standard deviation.

The percentage change of physiological stress from baseline to each phase was calculated for each physiological stress measure (Table 38).

Table 38 *Percentage change of physiological measurements from Baseline, descriptive data across phases between intervention arms of the RCT.*

Phase % vs Baseline	EDA Tonic (µS) *M* (*SD*)			EDA Amp (µS) *M* (*SD*)			HR (BPM) *M* (*SD*)		
	C	N	R	C	N	R	C	N	R
Phase 1	15 (18)	29 (31)	13 (13)	14 (20)	23 (30)	9 (12)	6 (13)	11 (9)	9 (7)
Phase 2	15 (23)	24 (33)	9 (10)	15 (24)	18 (33)	5 (10)	0 (7)	8 (15)	6 (13)
Phase 3	16 (23)	23 (36)	10 (9)	15 (20)	13 (31)	2 (10)	1 (14)	3 (6)	8 (11)
Phase 4	15 (21)	17 (23)	7 (8)	12 (19)	12 (24)	5 (12)	-2 (8)	4 (11)	3 (10)
Phase 5	15 (19)	14 (23)	6 (8)	16 (18)	12 (23)	2 (10)	1 (7)	2 (7)	4 (7)

Note: C= Control, N=Neutral, R= Reassuring % =Percentage change from baseline, µS = Microsiemens, BPM = Beats Per Minute, EDA Tonic = electrodermal activity tonic measurement, EDA M Amp= electrodermal activity mean amplitude measurement. HR = Heart Rate measured via BPM, M=Mean, SD= standard deviation.

Repeated measures ANOVA were used to investigate the effect of phase and arm on levels of physiological stress percentage change calculated from baseline across phases (Table 39).

Table 39 *Summary table representing ANOVA repeated measures results for physiological stress measurements percentage change across phases and between intervention arms, within the RCT.*

Measure	Simple main effect of phase within group				Between subjects effect				Interaction phase*intervention			
	F	*df*	*p*	ηp^2	*F*	*df*	*p*	ηp^2	*F*	*df*	*p*	ηp^2
EDA Tonic (µS)	18.08	2.63, 176.364	.001	.21	3.96	2,69	.024	.11	3.13	5.26, 176.364	.009	.09
EDA Amp (µS)	15.35	1.94, 120.330	.001	.20	1.70	2,62	.192	.05	2.25	3.88, 120.330	.070	.07
HR (BPM)	9.37	3.20, 221.198	.001	.12	4.38	2,69	.016	.11	1.02	6.41, 221.198	.426	.03

Note EDA Tonic=electrodermal activity tonic measurement, EDA M Amp= electrodermal activity mean amplitude measurement. µS = Microsiemens, HR = Heart Rate as measured by BPM (Beats Per Minute).

For EDA Tonic percentage change, Sphericity was not assumed and Greenhouse-Giesser corrections applied. Results showed firstly a significant main effect of phase (Table 39). Post hoc analysis indicates that EDA Tonic significantly increased in percentage from Baseline to Phase 1 (22%, p <.001), Phase 2 (16%, p <.001), Phase 3 (17%, p <.001), Phase 4 (15%, p <.001) and Phase 5 (12%, p <.001) (Fig. 24), which remains significant at the Bonferroni corrected alpha of p =.003.

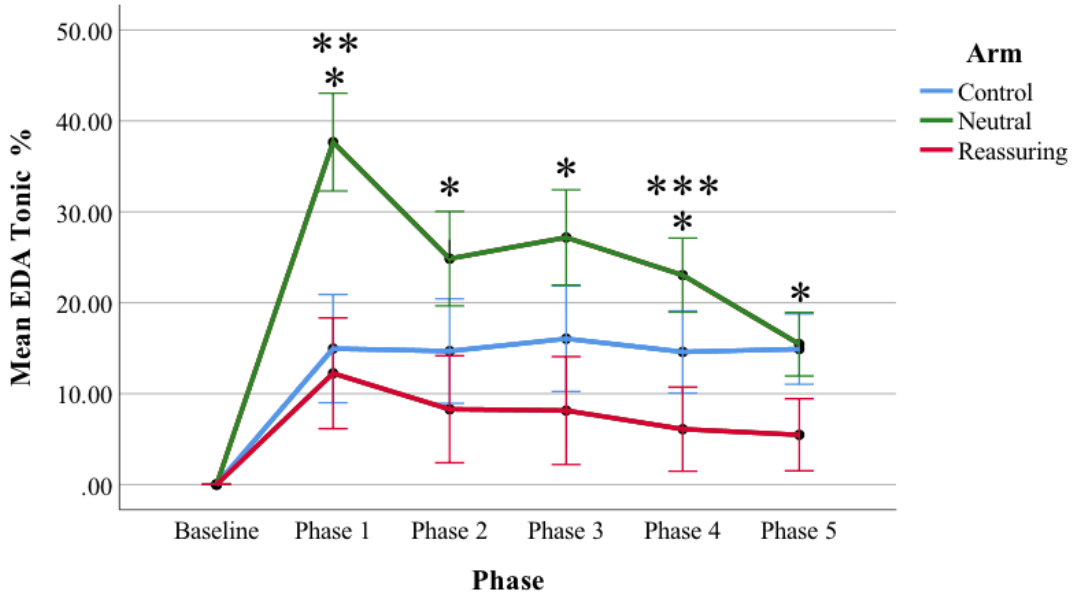

Figure 24 *Percentage change of EDA Tonic from baseline to phases between arms of the RCT.*
Note: %= percentage change from Baseline, Control = Blue line, Neutral = Green line, Reassuring = Red line, Error bars +/- 1 SE.
**, p<.05 vs Baseline, **,p<.05 Neutral vs Control, ***, p<.05 Neutral vs Reassuring.*

Additionally, EDA Tonic percentage change revealed a significant between subjects' effect of morph phase (Table 37, Fig 24). Post hoc tests revealed that the Neutral instruction arm had significantly higher levels of EDA Tonic percentage change across phases than the Reassuring group, with a mean difference of 1%, p = .022. The difference did not remain significant at a Bonferroni corrected alpha of p =.016.

Lastly an interaction was also observed between phase and arm (Table 37). Analysis of the simple main effects of each Phase, revealed that at Phase 1 an effect of arm could be observed F (1,69) = 6.20, p = .003, η_p^2=.16. Post hoc comparisons between arms indicate that at Phase 1, the Neutral arm had significantly higher increase in percentage of EDA Tonic from Baseline compared to the Control arm (23%, p = .006, Fig. 24), the difference remained significant at a corrected alpha of p =.016. Another significant simple main effect was observed for Phase 4, F (1,69) = 3.79, p = .028, η_p^2=.10. Post hoc comparisons between arms indicated that the Neutral arm had significantly higher percentage increase from baseline to Phase 4 than the Reassuring arm (17%, p =.008, Fig. 24), which remained significant at a corrected alpha of p =.016.

For EDA Amp percentage change, Sphericity was not assumed and Greenhouse-Giesser corrections applied. Levels of EDA Amp percentage change displayed a significant main effect of time. Post hoc pairwise comparisons revealed that levels of EDA Amp significantly increased in percentage change from Baseline to all subsequent including: Phase 1 (15%, p <.001), Phase 2 (13%, p <.001), Phase 3 (10%, p =.001), Phase 4 (10%, p <.001) and Phase 5 (10%, p <.001) (Fig. 25). These differences remained significant with the corrected alpha level of p =.004. Additionally Phase 1 had significantly higher increases in percentage change from Baseline compared to Phase 3 (5%, p <.001), and Phase 5 (5%, p <.001), which also remained significant with the corrected alpha. No significant between subjects effect of intervention arm, or phase x intervention arm intervention could be observed.

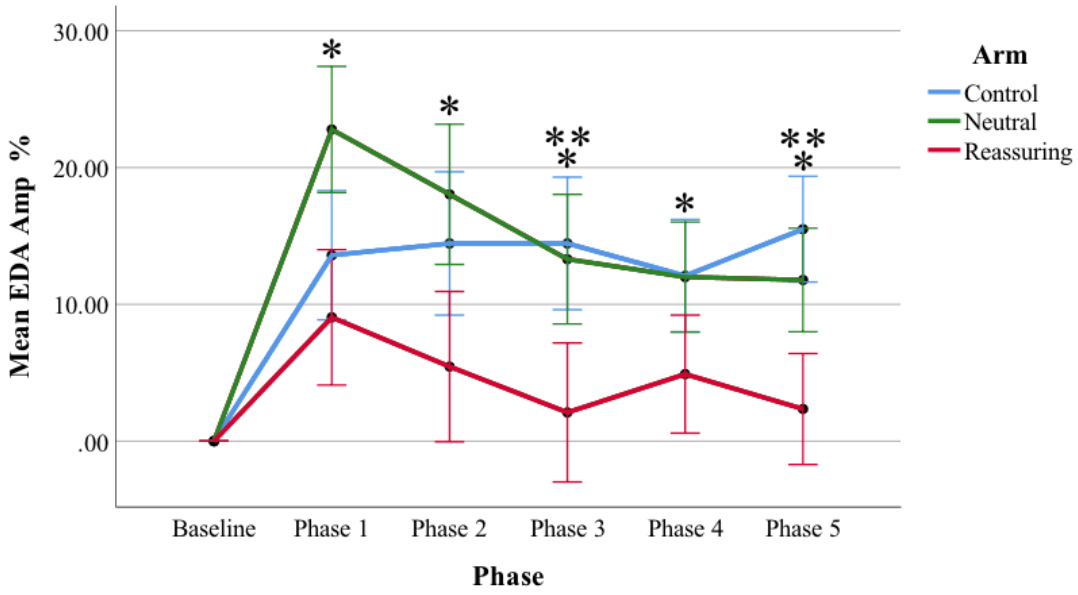

Figure 25 *Percentage change of EDA Amp from Baseline to phases between arms of the RCT.*
Note: %= percentage change from baseline, µS = microsiemens, Control= Blue line, Neutral=Green line, Reassuring= Red line. Error bars +/- 1 SE.
**, p<.05 vs Baseline, **, p<.05 vs Phase 1.*

For HR percentage change, Sphericity was not assumed and Greenhouse-Giesser corrections applied. Levels of HR percentage change displayed a significant main effect of phase (Table 39). Post hoc pairwise comparisons revealed that levels of HR significantly increased in percentage change from Baseline to subsequent phases including: Phase 1 (8%, p <.001), Phase 2 (4%, p =.003), Phase 3 (4%, p =.001) and Phase 5 (2%, p =.049), of which increases to Phase 1, 2 and 3 remained significant at a corrected alpha of p =.005 (Fig. 26). Additionally, post hoc comparisons revealed that levels of HR at Phase 1 had significantly higher increases in percentage change from Baseline to subsequent phases including Phase 2 (4%, p =.021); Phase 3 (4%, p <.001); Phase 4 (7%, p <.001) and Phase 5 (7%, p <.001) (Fig.26). Comparisons between Phase 1 and 2 did not remain significant at the corrected alpha level of p =.005.

A between subjects effects of intervention was found for percentage change of HR from Baseline (Fig. 26). Post hoc comparisons revealed that the Control arm had overall less percentage increase from Baseline compared to Neutral (4 % p = .012) and the Reassuring arm (4% p = .013), which remained significant at the corrected alpha level of p =.016.

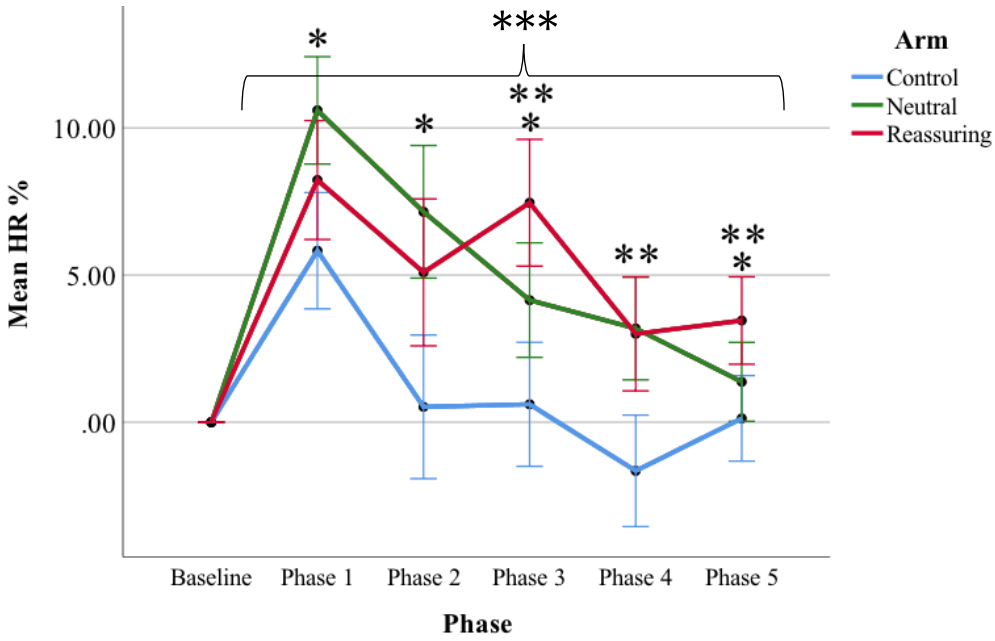

Figure 26 *Percentage change of HR from Baseline to phases between arms of the RCT.*
Note: %= percentage change from baseline, Control = Blue line, Neutral = Green line, Reassuring = Red line, BPM=Beats Per Minute, Error bars +/- 1 SE.
**, p <.05 Vs Baseline, **, p <.05 vs phase 1, ***, p<.05 Neutral + Reassuring Vs Control.*

9.4.7 Correlation analyses

Both subjective rating and physiological measurements were correlated to assess the relationships between the methods of stress measurement. Levels of subjective stress immediately post-intervention were positively correlated with the majority of EDA Tonic and EDA Amp measures at p <.05, ranging from weak to strong correlations. However, subjective stress at the end of the intervention session did not correlate significantly to measures of HR. Appendix 11 includes a table of all correlation coefficients.

9.4.8 Moderation and Mediation analysis

Moderation models were conducted using Process V3 macro (Hayes, 2017). Potentially moderating and mediating variables previously described (PSS, anxiety, depression, Appearance evaluation and orientation) were entered into models. As quit smoking intentions at 3-months post-intervention differed significantly between groups and was predicted by arm intervention, the percentage change variable was added as the outcome variable to moderation and mediation analysis.

9.4.8.1 Stress mediation

Mediator variables were correlated with the outcome measure of intentions at 3-months post-intervention to check whether they could be entered into the mediation model. None of the pre-defined stress measurements for mediation significantly correlated with the

primary outcome of quit smoking intentions at 3-months post-intervention. Therefore, results from correlations (Appendix11) prevented assessment of the mediation model results.

9.4.8.2 Moderation of stress and confounding variables

Mediators and moderators have been defined in research as separate concepts, however both describe the influence of a defined variable on the intervention outcomes (Baron and Kenny, 1986). Therefore, as mediation models could not be calculated, in order to further explore the impact of the stress response on intervention outcomes, stress variables were entered into moderation models alongside other potentially moderating variables.

The intervention arm was entered as the predictor in analysis models, as a categorical independent variable. Therefore, Control participants were used as the reference category for coding of dummy variables. The first dummy variable (D1) compares Control and Neutral participants, and the second dummy variable (D2) compares Control and Reassuring participants. The changes in R^2 that results from adding the interactions of dummy variables with the outcome variable was used to test the moderation model. A significant change in R^2 indicates that levels of the moderation variable moderated the relation between intervention condition and the outcome variable.

9.4.8.2.1 Physiological stress moderation

Moderation variables included the measurements of physiological stress (EDA Amp, EDA Tonic and HR). Physiological stress variables displayed significant moderation models, with the outcome variable of quit smoking intentions at 3-months post-intervention. Table 40 outlines model summaries of the models calculated.

Out of those with significant models, interaction coefficients are provided (Table 41). Interactions were non-significant and found to cross the 95% confidence interval boundary in all instances. Indicating physiological stress did not moderate the impact of intervention condition on smoking intentions.

Table 40 *Model Summaries of physiological stress moderation analysis within the RCT*

Phase	*R*	R^2	*F*	*df*	*p*
EDA Tonic					
Morph2D	.38	.15	2.18	5,64	.067
Morph2D_R	.38	.15	2.17	5,64	.068
Morph2D_R'	.38	.15	2.18	5,64	.068
Morph3D	.38	.15	2.17	5,64	.069
Morh3D_R	.38	.15	2.18	5,64	.067
EDA Amp					
Morph2D	.38	.15	2.15	5,63	.071
Morph2D_R	.37	.14	1.93	5,62	.102
Morph2D_R'	.37	.13	1.93	5,62	.103
Morph3D	.38	.14	2.16	5,64	.070
Morh3D_R	.38	.14	2.07	5,62	.081
HR					
Morph2D	.39	.15	2.37	5,66	.049
Morph2D_R	.39	.16	2.42	5,66	.045
Morph2D_R'	.38	.15	2.25	5,66	.059
Morph3D	.40	.16	2.43	5,66	.044
Morph3D_R	.40	.16	.2.53	5,66	.037

Note: Outcome - intentions at 3-months post-intervention. EDA Tonic = electrodermal activity tonic measurement, EDA Amp = electrodermal activity mean amplitude measurement. HR = Heart Rate as measured by BPM.

Table 41 *Interaction coefficients of significant physiological stress moderation models within the RCT*

Interaction	Coeff	SE	*t*	*p*	CI
HR Morph2D					
D1	-.16	.71	-.22	.828	-1.580,1.269
D2	-.89	.88	-1.01	.317	-2.6486,.8720
HR Morph2D_R					
D1	-.11	.91	-.12	.906	-1.913,1.699
D2	-.90	.80	-1.08	.285	-2.473,.739
HR Morph3D					
D1	-.00	.81	-.01	.996	-1.624,1.616
D2	-.90	.87	-1.03	.305	-2.624,.833
HR Morph3D_R					
D1	.03	.80	.04	.971	-1.571,1.628
D2	-1.10	.93	-1.18	.243	-2.965,.764

Note: Outcome - intentions at 3 months post-intervention, CI = confidence interval 95%, HR= Heart Rate as measured by BPM, D1= Control vs Neutral, D2= Control vs Reassuring.

9.4.8.2.1.1 Subjective stress moderation

Via moderation analysis, subjective stress after intervention delivery was found to moderate the relationship between intervention arm and quit smoking intentions at 3-months post-intervention $\Delta R^2 = .31$, $F\ (5, 66) = 3.95$, $p < .001$. A significant interaction was present for the dummy variable D2 (Control vs Reassuring) $b_{D2} = .45.92$, $SE = 18.04$, $t = 2.55$, $p = .013$, 95% CI [9.8975, 81.9514]. No significant interaction was found for the dummy variable D1 (Control vs Neutral).

The significant interaction for D2 was examined further by probing the conditional effect of intervention arm on quit smoking intentions at three values of the moderator including, i) the sample mean, ii) one standard deviation above the mean (high) and iii) one standard deviation below the mean (low). At low levels of subjective stress, there was no significant effect in quit smoking intentions in both D1 b_{D1} =5.87, SE = 14.33, t = .41, p = .683, and D2 b_{D2} = -16.59, SE =19.12, t = -.87, p = .389. The same pattern was found at relatively moderate levels of subjective stress; there was no significant effect in D1, b_{D1} = 2.93, SE = 12.12, t = .24, p = .809, and D2, b_{D2} = 19.36, SE = 13.39, t = 1.45, p = .153. At relatively high levels of subjective levels of stress, there was no significant effect in D1, b_{D1} = -.01, SE = 19.94, t = -.00, p = 1.00, However, there was a significant difference in D2 (comparison of control and Reassuring participants) b_{D2} = 55.31, SE = 19.80, t = 2.79, p = .007. The significant effect suggests that participants in the Reassuring arm had higher level of quit smoking intentions than participants in the Neutral and Control arms when they exhibited high levels of subjective stress; yet no differences were observed at low and moderate levels of subjective stress. See Fig. 27 for a plot of the moderation effect on the primary outcome.

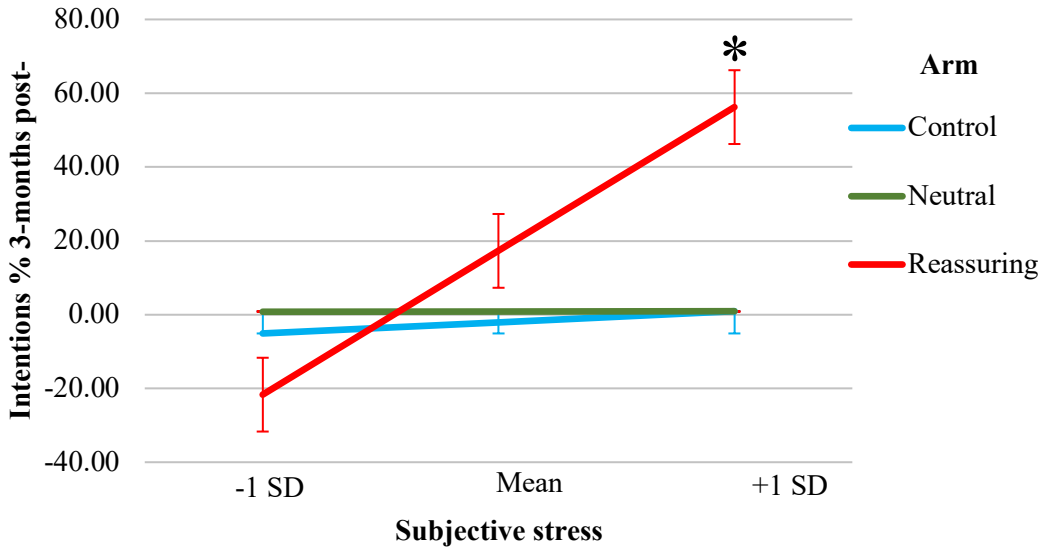

Figure 27 *Subjective stress moderation model of quit smoking intentions within the RCT.*
Note: % = percentage change from baseline, -1 SD below the mean= Low, Mean = Moderate, +1 SD above the mean = High. Control= Blue line, Neutral= Green line, Reassuring= Red line, Error bars: =/- 1 SE
**, p<.05 Control vs Reassuring*

9.4.8.2.1.2 Confounding variable moderation

Additional moderation variables included Appearance evaluation and Appearance orientation (pre-intervention), PSS (pre-, 1- and 3- months post-intervention), anxiety (pre-, 1- and 3- months post-intervention) and depression (pre-, 1- and 3- months post-

intervention). Some variables exhibited significant moderation models for quit smoking intentions at 3-months post-intervention. Table 42 outlines summaries of the models calculated. For the significant models, interaction coefficients are provided (Table 43).

Table 42 *Model Summaries of potential moderation variables, moderation analysis within the RCT.*

Moderator	*R*	R^2	*F*	*df*	*p*
Appearance evaluation	.45	.20	3.28	5,66	.010
Appearance orientation	.38	.14	2.19	5,66	.066
pre-intervention PSS	.43	.18	2.95	5,66	.018
1-months PSS	.54	.30	4.20	5,50	.003
3-months PSS	.47	.22	2.59	5,46	.038
pre-intervention anxiety	.32	.11	1.60	5,66	.190
1-months anxiety	.47	.22	2.86	5,51	.024
3-months anxiety	.47	.22	2.44	5,43	.049
pre-intervention depression	.51	.26	4.72	5,66	.001
1-months depression	.45	.20	2.69	5,54	.031
3-months depression	.43	.18	2.10	5,47	.082

Note: Outcome- intentions 3-months post-intervention, df = degrees of freedom, PSS = Perceived Stress Scale

Table 43 *Interaction coefficients for significant confounding variables, moderation models within the RCT.*

Interaction	Coeff	SE	*t*	*p*	CI
Appearance evaluation					
D1	-.92	2.07	-.45	.658	-5.059,3.216
D2	-4.46	2.13	-2.10	.040	-8.713,-.214
pre-intervention PSS					
D1	.34	1.98	.17	.864	-3.6175,4.2969
D2	2.67	2.04	1.31	.194	-1.3925, 6.7351
1-month PSS					
D1	.62	1.70	.37	.72	-2.7866, 4.0246
D1	-3.48	1.76	-1.98	.053	-7.0041, .0487
3-month PSS					
D1	.87	1.02	.85	.401	-1.1920, 2.9286
D2	-.52	1.02	-.51	.613	-2.5726, 1.5345
1-month anxiety					
D1	-.33	2.81	-.12	.906	-5.972,5.307
D2	1.55	2.79	.56	.581	-4.048,7.149
3-months anxiety					
D1	-.64	1.51	-.43	.673	-3.680,2.397
D2	-1.36	1.53	-.89	.379	-4.440 ,1.721
pre-intervention depression					
D1	.60	4.08	.15	.884	-7.543, 8.743
D2	10.62	4.34	2.44	.017	1.945, 19.290
1-month depression					
D1	-.37	4.57	-.08	.937	-9.516,8.786
D2	-7.23	5.29	-1.37	.178	-17.838,3.389

Note: Outcome= intentions 3-months post-intervention, CI= confidence interval 95%, D1= Control vs Neutral, D2= Control vs Reassuring

The majority of models displayed interactions that crossed the 95% confidence interval boundaries, indicating no moderation occurred. Depression pre-intervention and

Appearance evaluation remained as significant models; results are outlined in more detail below.

The variable of Appearance evaluation was found to moderate the relationship between condition and quit smoking intentions at 3-months post-intervention. $\Delta R^2 = .20$, $F(5, 66) = 3.28$, $p = .010$. A significant interaction was present for D2 dummy variable (Control vs Reassuring) $b_{D2} = -4.46$, $SE = 2.13$, $t = -2.09$, $p = .04$, 95% CI [-8.712, -.213]. No significant interaction was found for D1 (Control vs Neutral). The significant interaction was examined further by probing the conditional effect of the intervention arm on quit smoking intentions at three values of the moderator Appearance evaluation including, i) the sample mean, ii) one standard deviation above the mean (high) and iii) one standard deviation below the mean (low). At low levels of appearance evaluation, there was a significant effect in quit smoking intentions in D2 $b_{D2} = 60.97$, $SE = 16.87$, $t = 3.62$, $p = .001$. At relatively moderate levels of Appearance evaluation, there was a significant difference in D2 (comparison of Control and Reassuring participants) D2, $b_{D2} = 34.82$, $SE = 12.68$ $t = 2.75$, $p = .008$. The significant effects suggest that Reassuring participants had higher levels of quit smoking intentions than Neutral and Control participants when they exhibited both low and moderate Appearance evaluation; yet no differences were observed at high levels. See Fig. 28 for a plot displaying the moderating effect of Appearance evaluation scores.

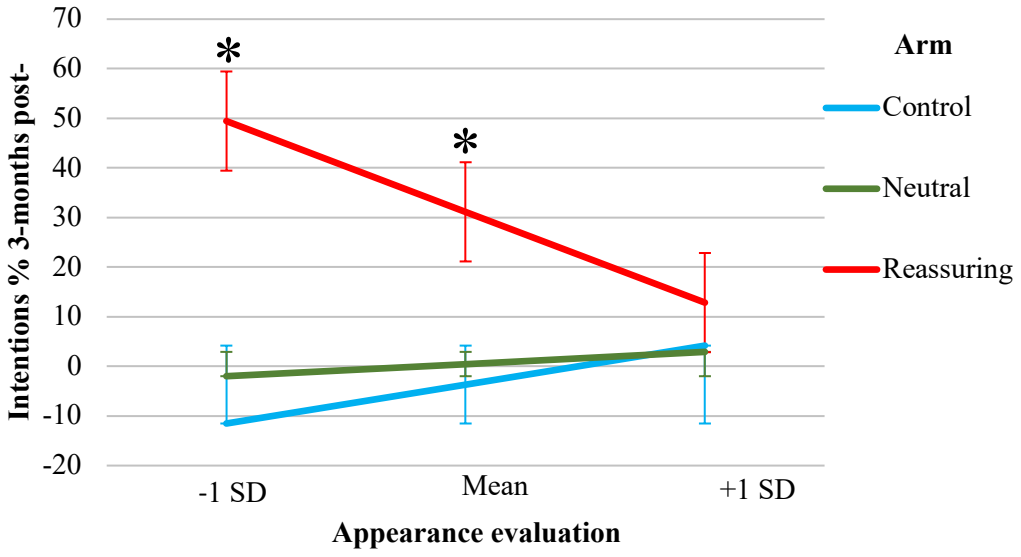

Figure 28 *Appearance evaluation moderation plot of quit smoking intentions within the RCT.*
Note; -1 SD below the mean = Low, Mean = Moderate, +1 SD above the mean= High. Control = Blue line, Neutral= Green line, Reassuring= Red line, Error bars: =/- 1 SE
**, p<.05. Control vs Reassuring*

The variable of pre-intervention depression was found to moderate the relationship between arm and quit smoking intentions at 3-months post-intervention. $\Delta R^2 = .26$, $F(5, 66) = 4.72$, $p = .001$. A significant interaction was present for D2 dummy variable (Control vs Reassuring) $b_{D2} = 10.62$, $SE = 4.34$, $t = 2.44$, $p = .017$, 95% CI [1.9448, 19.2905]. No significant interaction was found for D1 (Control vs Neutral). The significant interaction was examined further by probing the conditional effect of the intervention arm on quit smoking intentions at three values of the moderator depression including, i) the sample mean, ii) one standard deviation above the mean (high) and iii) one standard deviation below the mean (low). At low levels of depression scores pre-intervention, there was no significant effect in quit smoking intentions in both D1 $b_{D1} = 2.06$, $SE = 18.01$, $t = .11$, $p = .910$, and D2 $b_{D2} = 13.12$, $SE = 18.32$, $t = .72$, $p = .477$. At relatively moderate levels of depression, there was no significant effect in D1, $b_{D1} = 3.82$, $SE = 11.77$, $t = .33$, $p = .747$. However, there was a significant difference in D2 (comparison of Control and Reassuring participants) D2, $b_{D2} = 44.35$, $SE = 12.47$ $t = 3.56$, $p = .001$.The same pattern was found at relatively high levels of depression scores pre-intervention; there was no significant effect in D1, $b_{D1} = 5.59$ $SE = 15.52$, $t = .36$, $p = .720$, and a significant difference in D2 (comparison of Control and Reassuring participants) D2, $b_{D2} = 44.35$, $SE = 12.47$, $t = 3.56$, $p = .001$.

The significant effects suggest that participants in the Reassuring arm had higher levels of quit smoking intentions than Neutral and Control participants when they reported both moderate and high levels of depression scores pre-intervention; yet no differences were observed at low levels. See Fig. 29 for a plot displaying the moderating effect of depression scores.

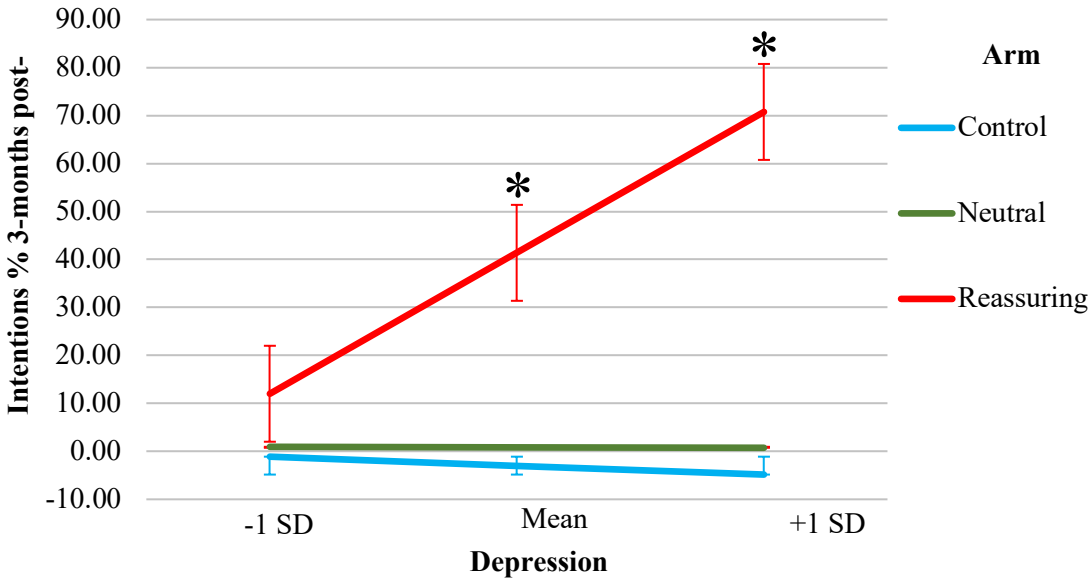

Figure 29 *Pre-intervention depression moderation of quit smoking intentions plot within the RCT*
Note: -1 SD below the mean = Low, Mean = Moderate, +1 SD above the mean = High. Control = Blue line, Neutral = Green line, Reassuring = Red line, Error bars: =/- 1 SE
**, p<.05 Control vs Reassuring.*

9.5 Discussion

9.5.1 Summary of findings

The overarching aim of the current study was to assess the impact of the age-progression intervention arms (Neutral and Reassuring) and an active Control intervention arm on the primary (intentions) and secondary (attitudes, PBC, SN, sum of cigarettes) outcomes. The study also examined the impact of the intervention on the stress response, how stress response differed between interventions, and how stress response impacted on follow up outcomes measured at post-intervention, 1-, 3- and 6-months post-interventions. Lastly, the impact of mediating and moderating variables of stress and other possible confounding factors such as anxiety and depression, was explored for the smoking outcomes measured.

The study found a main effect of the intervention arm on the primary outcome variable of quit smoking intentions at 3-months post-intervention. The Reassuring intervention arm had the higher levels of quit smoking intentions above the Control arm responses. Additional repeated measures analysis also revealed that there was a between subjects' main effect for quit smoking intentions across all follow up time points, in which again the Reassuring arm had a significantly higher level of quit smoking intentions in

comparison to Control. The finding relates to the testing of hypothesis one. The Reassuring intervention arm (but not the Neutral arm), had significantly greater quit smoking intentions scores than the Control arm. No significant differences were found between Reassuring and Neutral arms. However, as differences between arms were observed, hypothesis 1 is therefore demonstrated to be partially supported by the findings. Furthermore, analysis of binary outcome variables also indicated that at 6-months post-intervention the majority of participants that reported being abstinent were in the Reassuring arm, while no participants in the Control arm reported abstinence at 6-months post-intervention administration. Results from the primary and secondary outcomes, indicates effectiveness of the age-progression intervention arms (especially the Reassuring arm) in impacting smoking intentions and behaviour.

The subjective and physiological stress response elicited by the interventions were measured. The physiological stress response (EDA and HR) was increased in response to the intervention as compared to Baseline measures in all arms. An interaction between phase of measurement and intervention arm was also observed as levels of the EDA Tonic response was significantly higher in the Neutral arm, compared to the Reassuring and Control arms at different phases of the intervention delivery. Furthermore, measures of HR indicated that the Control arm had significantly lower HR than both intervention arms throughout intervention delivery. Subjective stress differences were observed between arms at the end of the intervention session, before a return to near baseline levels in all arms after the leaflet delivery. At the end of the intervention delivery the Reassuring arm had significantly higher levels of subjective stress compared to the Control (but not the Neutral) arm. Hypothesis 2 predicted that age-progression intervention arms would display a significantly higher level of stress in comparison to the Control arm. Therefore, results from both subjective (Reassurance arm showed the highest subjective stress) and physiological (Neutral arm showed the highest EDA, and both Neutral and Reassuring had higher HR reactivity than Control) stress response support hypothesis 2. Conversely, the prediction that the stress response would differ depending on instruction type (Neutral and Reassuring) was partially supported by the physiological measure of EDA Tonic and not subjective stress levels. This may be in part due to different time periods of measurement and sensitivity of measurement tools.

Variables were entered into mediation and moderation models with the significant primary outcome of quit smoking intentions at 3-months post-intervention. Mediation

analysis including measures of the stress response did not meet the requirements for model calculation. Subsequently variables were entered into moderation analysis to asses if they had a moderating effect on the primary outcome variable. It was indicated that participants in the Reassuring intervention arm that exhibited higher levels of subjective stress immediately post-intervention, were more likely to have higher levels of quit smoking intentions at 3-months post-intervention. Physiological measurements of stress did not moderate the intervention arm effect. As a measurement of the stress response (subjective stress) moderated the primary outcome, the exploratory aim of the study was met, as stress when increased has been demonstrated to increase the efficacy of the age-progression intervention.

Furthermore, when looking at other potential moderating influences on smoking behaviour, significant models were observed for both levels of depression and Appearance evaluation. The model showed that participants in the Reassuring intervention arm that exhibited i) low or moderate scores of Appearance evaluation or, ii) both moderate and high levels of depression scores pre-intervention, were more likely to have higher levels of quit smoking intentions at 3-months post-intervention. Thus indicating that for participants in the Reassuring arm, lower perceived satisfaction with their own appearance and lower levels of depressive symptoms relate to increased intervention efficacy.

9.5.2 Discussion of findings

Findings from the primary and secondary outcome variables are in line with findings from previous research in the UK (Grogan et al., 2011) and of results in Australia (Burford et al., 2013) which used RCTs to investigate age-progression interventions for smoking cessation. In the current research, quit smoking intentions were increased within the Reassuring arm in comparison to the Control arm, supporting previous findings investigating the age-progression intervention delivered via non standardised instructions compared to control interventions of varying stop smoking advice and information. Results indicated the current research demonstrated a similar effect of the intervention, when taken out of the context of a quit smoking service, and with the implementation of a consistent set of instruction types across arms. In addition, the current investigation displayed an effect of the intervention at the longitudinal time point of 3-months post-intervention only, whereas previous research only evidenced an effect of the intervention at immediately post-delivery (Grogan et al., 2011). The intervention was not evidenced

to impact intentions and behaviours immediately post-intervention. Levels of intentions could have been raised in the Reassuring arm (arm with the lowest starting intentions) due to the catalyst of the intervention administration, reaching significance only at the 3-months post-intervention time points. Whereas in previous research an immediate effect was observed, but no sustained difference in smoking outcomes was observed.

The current results also parallel findings of the previous RCT implemented in Australia which evidenced more prevalence of thirty-day point of abstinence in comparison to a control at 6-months post-intervention. In the current study, none of the Control participants were abstinent at 6-months post-intervention, whereas 9.1% of the Neutral group and 30.8% of the Reassuring group did indicate abstinence. Although the current study had less participants at the 6-month time point, and a shorter period of abstinence was measured, the proportion of abstinent participants in the Reassuring arm (30.8%) is comparable to Burford et al. (2013) findings (27.5%), indicating the Reassuring group may be effective in producing behaviour change.

A limitation highlighted in previous investigations of the efficacy of age-progression interventions for smoking cessation, is that only the intentions of smokers are changed while behaviour remained unaffected. The difference between intended behaviour and action has been described by researchers as the intentions- behaviour gap (Armitage and Conner, 2001). Bridging this gap i.e. changing both intentions and behaviours is a key component to the success of behavioural interventions (Sheeran and Webb, 2016). The current findings build on and incorporate suggestions from previous research through providing evidence that both intentions and behaviours are changed in participants who received the age-progression intervention. Participants delivered the Reassuring instruction arm displayed increased levels of both smoking intentions at 3-months and behaviours at 6-months post-intervention. As behaviour is suggested to be harder to change than intentions (Sheeran and Webb, 2016), indication that behaviour was changed in a small group of participants adds to the argument of that age-progression interventions is a brief and low-expensive intervention with promise in affecting a wide range of women who smoke. Additionally, the Reassuring instruction arm was more effective in producing this change than the Neutral instruction arm.

One key mechanism that could be attributed to the intervention success is the ability of the intervention to increase the level of personal threat smoking poses to the individual.

As evidenced in qualitative accounts from previous published research (Flett et al., 2017; Grogan et al., 2010a) and qualitative data within the thesis (Chapter 7), age-progression interventions create a high level of perceived personal threat of the damaging effect of smoking to the skin (Grogan et al., 2010a). Within the current investigation, the role of threat could be viewed through the action of the stress response on the smoking outcomes. The results of the present study indicate that levels of subjective stress moderate the relationship between the intervention arm and smoking intentions, specific to the Reassuring arm. This suggests that the stress response experienced during intervention delivery has an influence on the intervention long-term outcomes. Meta-analysis research has previously reported a linear relationship between threat or stress and persuasion of behaviour change in health behaviours, and most specifically smoking (Dillard et al., 2017). Most previous research has investigated the influence of threat on behaviour through in-between groups design. Groups of participants are administered varying degrees of threat inducing material, after which measurements of stress and behaviour are obtained. Research of this kind indicated individuals induced to have higher stress were more likely to be persuaded to change their behaviour, demonstrating a linear relationship between threat and behaviour change (Witte and Allen, 2000; Tannenbaum et al., 2015; Boster and Mongeau, 1982). The current research is in support of the linear relationship as the Reassuring arm has induced higher levels of subjective stress and in turn has reduced smoking behaviour and increased intention to quit.

Responses to measures of subjective stress indicated that the Reassuring instruction arm had the highest level of subjective reactivity to the intervention. This supports results from both qualitative and quantitative pilot study evidence, as participants administered Reassuring instructions expressed the most shock and an increased stress response, in comparison to participants administered the Neutral arm. The effect of the Reassuring instructions on the stress response is therefore under scrutiny as it appears to be reliably creating an opposite outcome from the one intended, i.e., increasing, instead of reducing the stress response. Interestingly, a similar effect has been reported by Closa Leon et al. (2007). In this study (Closa Leon et al., 2007), participants that received supportive instructions, that reassured the participant prior to an anger stress inducing task, or during the recovery phase, increased cardiac output reactivity to the task, in comparison to participants within the neutral condition. However, no significant differences between the groups were observed in HR. These results are congruent to those found in the subjective stress response in the RCT study. In addition, it is important to note, that as Closa Leon

et al. (2007), we did not find significant differences in HR, suggesting that i) other systems involved in the stress response could be related to the increase of subjective stress, or ii) the physiological measures used in this study did not capture the physiological alterations induced by the reassuring statements, or both.

The mechanisms in which reassurance increased levels of stress may however lie in the verbal content used in the instructions. Verbal reassurance has previously been discussed in the context of a medical assessment, to have two classes of verbal cues. This includes statements intended to emotionally reassure and the second to indicate the absence of the relevant disease or condition (Coia and Morley, 1998). The effect of verbal reassurance is not well understood yet, while some research suggests it does reduce fear, on the other side it is evidenced to create a paradoxical effect in which fear is increased (McDonald et al., 1996). Therefore, the emotionally reassuring statements used for the Reassuring intervention instructions, could have induced an increased level of fear within participants. This paradoxical effect of the Reassuring instructions aligns with the Ironic Process Theory (Wegner, 1994) that proposes that deliberate attempts to supress certain thoughts could make them more likely to appear, especially under conditions that reduce cognitive capacity (such as, under stress). Fear and stress are closely related and activate similar pathways in the brain (Ressler, 2010), explaining how participants demonstrated both shock and fear in qualitative accounts (Chapter 6), and stress (Chapter 8 and the current chapter) towards the intervention delivery.

Previous research that has looked at fear appeals and specifically the use of increasing perceived risk through visual images in the context of reducing UV exposure, suggest that refining key concepts and mechanism of the fear and stress is imperative to research of this kind (Pokharel et al., 2019). This includes the measurement of the stress response through physiological methods. The current research introduces this recommendation through measuring physiological autonomic changes in stress, throughout intervention and control delivery. Within the current study, compared to subjective levels of stress, the measured physiological stress response evidenced an increase response in both intervention groups. Tonic levels of EDA were increased in the Neutral group above that of the Control, and in comparison to the Reassuring arm. The physiological stress response is indicated to be both distinct and intertwined with subjective stress (Sommerfeldt et al., 2019). Empirical evidence from a meta-analysis indicates that there is a lack of coherence between the measurements of subjective and biological markers of

stress (Campbell and Ehlert, 2012), due to interindividual features in the adaptive mechanisms to stress. Interindividual differences within the measurement of stress, include but are not limited to, differences in the time to reach peak levels of arousal (Sommerfeldt et al., 2019), as well as differences in circuitry and asymmetry of the prefrontal cortex and amygdala, influencing reactivity to affective cues (Davidson, 2000). Variations in the stress response could have been present in the current sample due to the broad sample of women obtained, preventing the replication physiological stress from previous chapter (Chapter 8) and the subjective rating.

One factor which may have influenced the measures of physiological stress reactivity is the age of the participants. It was indicated in analysis comparing those participants above and below age 35, that older women in the current study showed elevated levels of physiological stress, compared to those under 35 (Appendix 12). Age creates different psychophysiological arousal in older adults; however, the evidence is not conclusive as to the direction of this difference (Lau et al., 2001). As the current study had a majority of women under the age of 35, differences regarding age could not be fully informed. Another factor that could have influenced the measurement of physiological stress reactivity is specific menstrual phase (Espin et al., 2019). Menstrual phase has the capacity to attenuate or heighten the physiological stress response. However, within the current sample no significant differences were observed between menstrual phase groups on measures of the physiological stress response (Appendix 12). The implementation of more sensitive measurements of menstrual phases in future research, may aid assessment of menstrual phase effects (Wetherill et al., 2016).

Previous research has been criticised for only measuring variations in threatening stimulus and intentions between arms (Dillard et al., 2017). While there is a lack of research that measures the subjective and or physiological experience of those participants during the intervention, that would provide evidence for the within person experience. The current research takes recommendations from previous research by providing evidence for the curvilinear model (Hovland et al., 1953). The stress experienced by participants is measured throughout the intervention, not only on a between groups post-intervention level. The curvilinear model indicates that when fear and stress is firstly increased and then subsequently decreased, recommendations for behaviour change tend to be accepted (Dillard et al., 2017). The current research evidenced an increase of subjective stress response from pre- to immediately post-

intervention and a reduction to near baseline levels of subjective stress after a 5-minute period. Therefore, the recommendations that were advocated by the age-progression software may have been more easily accepted by the participant, specifically in the Reassuring intervention arm, due to the significant increase and subsequent curvilinear decrease of the subjective stress response.

The age-progression intervention was evidenced to increase levels of threat and stress and could therefore be considered a threat-based approach to behaviour change. A criticism of threat-based approaches is that it could increase avoidance towards the intended message of the intervention within participants (Tannenbaum et al., 2015; Janis and Feshbach, 1953; Millman, 1968), decreasing the effectiveness of the message delivered. Conversely, avoidance created by fear and threat could be overcome by providing instructions on how to successfully achieve smoking cessation and convince individuals they are personally at risk (Ruiter et al., 2014), the latter was achieved through the personal aged image used with the age morphing intervention. Additionally, the action of raising threat could have induced the level of attentional vigilance (sustained allocation of attention) towards subsequent stop smoking information provided (Blondé and Girandola, 2018), that would not be accomplished without the initial threat. When information is processed under threatening conditions, it is suggested that coping information is more likely to be accepted due to the need to eliminate the threat that is conveyed (Maloney et al., 2011; Witte, 2008). Therefore, by firstly increasing threat through displaying the damaging effects of smoking and then providing information on how to change this behaviour, the route to effective smoking cessation could be highlighted for the participant, as both risk and instructions for change are provided (Ruiter et al., 2014). Future research could add to this management of avoidance and implement recommendations to further combine the age-progression content with more health interventions in the moment where attentional vigilance to message content could be increased (Blondé and Girandola, 2018).

Perceived threat to the effects of smoking on the skin could have also be increased in participants who were more concerned, and less satisfied, with their own physical appearance. The current study evidenced a moderating effect of low and moderate levels of Appearance evaluation (measured pre-intervention), on smoking intentions at 3-months, specific to the Reassuring arm. In other words, those participants more dissatisfied with their own appearance (low in appearance evaluation) showed increased

intention to quit. Appearance dissatisfaction could have increased attentional bias towards the most positive image presented during the intervention. Research on body satisfaction has showed that women unsatisfied with their own facial appearance, when showed attractive and unattractive faces, first displayed eye fixation on unattractive faces, followed by sustained fixation on the more attractive faces (Kou et al., 2016). Based on these findings, it is possible to speculate that during the age-progression intervention, participants with low and moderate levels of Appearance evaluation could have first attended to the smoking aged image, before moving to fixate on the non-smoking (more attractive) alternative. This attentional trajectory may increase perceived risk of smoking on facial ageing, while gaining awareness of the possibility of a more positive outcome through the natural (without smoking) ageing process, increasing intentions to quit. Importantly, this moderating effect was specific to the Reassuring arm, i.e., the arm with the highest levels of stress elicited by the intervention, and as argued above, the increased stress could have driven even more attention to the intervention images (Kessels et al., 2010). However, a note of caution needs to be mentioned in relation to appearance and behaviour change, as amplified emphasis on appearance concern could decrease self-esteem (O'Dea, 2012), potentially resulting in other negative health behaviours. In the current study, participants were asked to self-exclude if they perceived themselves to have issues surrounding body image and great care was taken in the debriefing process to mitigate any potential negative consequences. Furthermore, the focus on the natural ageing process and addition of health information may increase the participants autonomy to choose how smoking affects both, their skin and health (Grogan, 2016).

Moderation analysis also indicated that the efficacy of the Reassuring arm on smoking intentions at 3-months post-intervention, was moderated by levels of depression at pre-intervention, with moderate and high depression levels showing an increase in intention to quit. The positive nature of this finding is surprising given that research suggests that depression can serve to maintain smoking behaviour and make smoking cessation harder to achieve (Morrell and Cohen, 2006). However, there are several points to consider in relation to this finding. First, the measure of depression within the study was a subscale of the overall the Hospital Anxiety and Depression scale, in which measures of depression and anxiety are highly correlated with each other evidenced in this study and previous research (Zigmond and Snaith, 1983). Even though in the current study depression and not anxiety had a moderating impact on the intervention outcome, a possible interaction effect with anxiety cannot be ruled out considering the sample size and low power of the

analyses. Second, the moderating effect of depression on the intervention efficacy could be related to the effect of appearance as discussed above, as negative body image has previously been linked to levels of depression (Brechan and Kvalem, 2015) and a significant relationship was observed between negative Appearance evaluation and increased depression scores in the current sample (Appendix 13). And finally, although a significant moderation effect existed, it should be noted that the depression scale (HADS-D) implemented within this study indicated a low internal consistency for the first two data collection time points ($\alpha < 0.4$; pre-intervention, and at 1-month post-intervention), though internal consistency increased at later time points ($\alpha > 0.6$; 3- and 6-months post-intervention), and previous research presents the scale as reliable in a range of populations (Bjelland et al., 2002; Langvik et al., 2016). However, even though appropriate checks were made on scoring and implementation of the questionnaire, no issues were identified to explain these low reliability scores within the sample of the current study. Therefore, further research is needed in order to replicate and confirm findings in relation to the moderating effects of depression on the age progression intervention efficacy.

9.5.3 Strengths of the research

One of the greatest strengths of the current research is the inclusion of a third arm in the investigation, which included variations in the age-progression intervention delivery, and subsequently, differences in the stress experienced. This allowed for the investigation of the most effective instruction set for delivery of the age-progression. The way in which the intervention was delivered, and the subsequent effect on intervention outcomes, has previously been overlooked by research which did not explain in detail how the intervention was delivered to the participant (Grogan et al., 2011; Burford et al., 2017; Burford et al., 2013). By setting clear intervention instructions, the impact of the intervention can be deduced and replicated, minimising interference from confounding effects of delivery, due to less variations in the experience of the intervention between participants.

Furthermore, another strength of the current research is the addition of both subjective and physiological measurement of stress. Measurement of stress reactivity allowed for the inference of the immediate impact of the intervention on the stress response, and the subsequent impact this response has on efficacy of the intervention. No previous research has included the measurement of stress in the context of age-progression interventions; however researchers have advocated for the inclusion of these measures (Pokharel et al.,

2019). Therefore, the current research successfully adds to our understanding and implements recommendations from previous research, in terms of studying the impact of short-term stress on behaviour change.

The study also provides the strength of robust study design, accomplished through the addition of protocol development, closely comparable active control condition, stratified randomisation, effective intent to treat analysis, and long-term longitudinal data collection. Improvements were made to the study design following from analysis of the strengths and limitations of the research in this area identified by the previous (Flett et al., 2013) and current systematic review (see Chapter 3). Hence, the current research serves to advance research investigating age-progression interventions for smoking cessation by creating valid and reliable results.

9.5.4 Limitations of study design

There are some limitations in the current research that need to be taken into consideration when interpreting the results. Firstly, the study sample recruited failed to reach the number required, however post hoc analysis of power did indicate the level of power reached near the recommended level of .80. Therefore, although a significant effect of the main outcome was observed, these results should be interpreted with caution.

Another limitation of the current research is that although women recruited were from a range of ages, the majority of women were under the age of 35. Older women were more difficult to target and recruit, and those recruited smoked on average more than those participants under the age 35. This trend may be indicative of the hardening hypothesis, whereby the participants that were willing to take part in research advertised as a smoking intervention, were the less addicted and more motivated to quit, representative of a younger population (Feliu et al., 2019a). Even though older women may have been more apprehensive regarding participation in the research, they should remain a target of research of this kind. Additionally, women over 35 within the UK may have busy working and caring responsibilities and very limiting time available for participation, preventing the scheduling of intervention appointments in some cases. Future research should therefore continue to actively engage this group of older women with the implementation of short form age-progression techniques, taking into account the participants' access and schedules.

Lastly, a limitation was present within the measurement of smoking behaviour. Smoking behaviour was measured via self-report methods across all pre- and post-intervention time points. The use of biochemical measurements of breath CO (the use of which is recommended as an objective and confirmatory measure of levels of smoking behaviour (Sandberg et al., 2011)) was only implemented at the intervention time point (when the participant attended the session) and not at subsequent follow up data collection, performed online. Given the main aim of the present study (to investigate the efficacy of the intervention at long-term in terms of intention to quit) the research design was built on recommendations of previous research which observed high levels of drop-out. Hence, to reduce attrition, as to limit the level of attrition at longitudinal time points, this was achieved in order to build on recommendations of previous research which observed high levels of drop-out.

9.5.5 Future directions of research

Below, recommendations are made for randomised trials of age-progression interventions for smoking cessation. Suggestions are based on the exploratory findings and limitations identified within the current investigation.

Firstly, future research should continue to target women from a range of ages and from a diverse range of socioeconomic areas. The current and previous research suggests the intervention is found acceptable in an older age range. In addition, recruiting a larger proportion of women within this demographic age would help to identify if differences exist in terms of the stress response. Moreover, it would help to infer whether older women (in this study reported as > 35) report less impact on smoking behaviour from the intervention. Future research should also consider continuing the implementation of standardised sets of instructions for the delivery of the intervention. Standardisation will serve to create reliable results in terms of the efficacy of the intervention. Furthermore, by manipulating the intervention delivery researchers can continue to investigate optimal conditions for the intervention to impact behaviour change. Additionally, researchers could continue to investigate the moderating role of stress. Through inducing and measuring varying levels of stress, optimal levels of stress can be implemented to increase the efficacy of the age-progression intervention for smoking cessation, or other health behaviour interventions.

9.5.6 Conclusions

The current study examined the effectiveness of an age-progression intervention for smoking cessation on immediate and longitudinal smoking cognitions and behaviour. The study also investigated the implementation of different instruction types and the subsequent stress response. The analysis displayed significant differences in the primary outcome variables of quit smoking intentions at 3-months post-intervention. Additionally, a larger proportion of women in the Reassuring intervention arm were abstinent at 6-months compared to both the Neutral and Control arms. Subsequently the Reassuring arm was indicated to be the highest in terms of subjective stress, which at high levels positively moderated the level of quit smoking intentions. The findings therefore indicate that when the age-progression intervention is delivered accompanied by Reassuring instructions, the induced levels of high subjective stress serves to increase the efficacy of the intervention.

The study was developed and designed through the implementation of both qualitative and quantitative pilot research, outlined in aforementioned chapters resulting in a robust study design. Some limitations have been identified including sample size and choice of measurement. Despite these limitations, the present study provides novel contributions to the field of smoking cessation and specifically age-progression interventions that has previously been overlooked in past research.

10 Chapter 10 General discussion

10.1 Introduction

The current thesis provides a comprehensive programme of research, which has generated important and novel findings in relation to age-progression interventions for smoking cessation and the role of the stress response. The thesis incorporates one systematic review, a mixed methods pilot investigation, an additional qualitative exploration and a Randomised Controlled Trial. Individual findings both support and challenge one another. When combined the findings from each investigation express how effective age-progression interventions for smoking cessation can be in a sample of women and highlight the importance of the stress response to the intervention. The current chapter outlines the findings presented in previous chapters and discusses the combined influence of the work as a whole. Implications for public health and health practitioners are outlined, in relation to the current findings. Furthermore, recommendations for future research are presented, indicating exciting directions for age-progression intervention research. It is concluded, that this thesis makes a substantive and innovative contribution to investigating the efficacy of age-progression interventions and provides new insights into the role of the stress response on intervention outcomes.

10.2 Summary of findings.

The research undertaken in this thesis achieved the primary aim of assessing the impact of an age-progression intervention in women (aged 18-55) on smoking outcomes, and the role of the stress response elicited by the intervention. The overall research aim was achieved through a series of individual studies in a linear progression, each with their own objectives. Each individual study fed into the development of the next, and finally towards the large-scale investigation. Four individual studies including; a systematic review (Chapter 3), a pilot study (Chapters 6 and 8), a qualitative exploration (Chapter 7) and an RCT (Chapter 9) were designed and conducted. Depending on the specific study aim, design, and methodology used, the results were analysed using a variety of techniques. The evidence gathered contributed to the understanding of the mechanisms underpinning the success of age-progression interventions for smoking cessation in women. Specifically, the role of the stress response while viewing the personalised morphed aged images was interpreted, utilising both theoretical and empirical findings drawn from chapter conclusions.

The first chapter presented a systematic review, which aimed to assess and update the current knowledge regarding appearance-based interventions for smoking cessation. Both the strengths and limitations of the research were identified and discussed for the development of later study design. The systematic review of the research on appearance-based interventions published between 2012 and 2017, indicated an increase in research quality from previous years (Flett et al., 2013). Additionally, a continued focus was observed on facial wrinkling type interventions, over other appearance based intervention types, such as weight gain concern reduction techniques. Differences in the methodology of the studies were highlighted regarding the number of intervention sessions, which ranged from one in person session within the facial wrinkling focused interventions (Flett et al., 2017; Burford et al., 2017; Burford et al., 2013; Song et al., 2013), to a series of several telephone calls (Bush et al., 2012), or face to face interventions sessions (Bloom et al., 2016). Contact with participants also varied in previous research between the intervention and Control arms of some of the identified studies. Examples of this are present within the facial wrinkling based interventions, in which control arms received significantly less contact with the researchers through delivery of short stop smoking information. Lastly, inclusion of effective control conditions was identified as a point of improvement for appearance based interventions for smoking cessation research. Not all of the identified papers included the comparison (Bloom et al., 2016; Song et al., 2013), which limited the quality of intervention based research.

It was concluded that further research on facial wrinkling type interventions for smoking cessation needed to address issues in study design (for example, inclusion of a control comparison group and equivalence of time between conditions), in order to provide strong evidence-based and reliable findings on the efficacy of this intervention type. Therefore, the systematic review within this thesis, in addition to reviewing and evaluating the efficacy of appearance based interventions for smoking cessation, made a valuable contribution to the existing literature through identification of the advancements needed in research design. Both appearance, and health concerns have been evidenced to motivate changes in behaviour (Persson et al., 2018b; Flett et al., 2013; Stead et al., 2013). Specifically, appearance is placed at greater importance due to its influence on how humans interact and are perceived in society (Frevert and Walker, 2014). The previous systematic review was conducted in 2012 (Flett et al., 2013), when studies investigating the efficacy of this, at that time, novel type of intervention using robust study design techniques were limited (mostly because of the exploratory nature of the studies). Prior

to Flett et al.'s (2013) review, public access to age morphing technologies (or applications) was practically non-existent. From 2017, popular face ageing apps have appeared in the mainstream and continue to gain popularity as evidenced through news reports in the past few years (Asmelash and Ries, 2019). The majority of these apps do not inform if simulation of wrinkling is based on evidence from the general population. Despite this, popularity reached by the apps demonstrate the public interest in appearance and age morphing technologies. Therefore, the systematic review was timely, updating our understanding and providing a strong evidence base to inform future research. This review supported the development of the research presented in this thesis in addition to widening the knowledge of the research area of appearance for behaviour change.

In addition to investigating the effectiveness of the intervention, an aspect of the overall aim of the thesis was to investigate the impact of stress reactivity to the age-progression intervention on smoking outcomes. Therefore, a pilot investigation was designed to trial the implementation of a research protocol. The pilot included two sets of instructions, developed to manipulate participants' levels of stress experienced during exposure to the intervention, and the use of the equipment required to measure the physiological stress response. The pilot study allowed for the investigation of i) whether physiological and subjective measures of stress were increased during the intervention ii) the feasibility of conducting a long-term RCT study, through monitoring recruitment and retention at long-term in the pilot study and perceptions of the research protocol iii) whether the two sets of instructions designed impacted in a different way participants' stress reactivity to the intervention. Lastly, iv) exploratory information regarding the experience of receiving the intervention and its efficacy. A mixed methods design was used in the pilot investigation. Qualitative methods were used to explore the experiences of participants of the intervention and procedure, while quantitative methods were used to investigate stress reactivity and levels of attrition.

Qualitative results from semi-structured interviews and focus groups indicated that the physiological equipment connected to the participants was not a distractor. The equipment was found unlikely to interfere with participants' experience of the age-progression intervention. Suggestions for the development of the research protocol were explored and trialled through the block recruitment, resulting in the development of a robust research design for the later RCT investigation. Furthermore, results from the qualitative exploratory investigation regarding the experience of participants with the

intervention, indicated that participants who received instructions with Reassuring content reported more accounts of and more intense levels of shock, in contrast to the Neutral instruction participants. Additionally, exploratory analysis of participants' experiences with the intervention indicated that accounts were consistent with previous findings. These similarities were demonstrated in regard to the intervention inducing quit smoking intentions and perceived risk to the self when viewing the intervention images. Qualitative findings demonstrate that the steps made in the improvement of the research protocol were successful (specifically, steps were made to ensure that design aspects related to the implementation of physiological measures were comfortable, and not distracting for participants during intervention delivery). Furthermore, exploratory results add strength to arguments from previous research with participants under 35 years old (Grogan et al., 2010a; Flett et al., 2017), demonstrating that women from a wide range of ages (18-55) were responsive to the intervention (Grogan et al., 2010b). Despite the ten year gap since the last qualitative investigation of the intervention within women (Grogan et al., 2010b), findings indicated that the intervention continues to elicit a shock response, giving indication of no habituation towards age morphing technologies within the general population.

Quantitative pilot findings illustrated that recruitment of participants was possible from both university and wider community settings. The results also demonstrated that dropout remained low up to 3 months of longitudinal assessment, after which rates of completion dropped. Procedures were then reviewed, and actions such as increasing the contact points with the participants during the follow up were implemented, in an attempt to maintain high levels of participant responses up to the 6 months post-intervention. In terms of the stress response, physiological measurements of stress demonstrated an increase in stress reactivity from Baseline, to during intervention administration. Furthermore, during the intervention, participants in the Reassuring condition demonstrated higher levels of stress than the participants in the Neutral condition. Quantitative pilot findings made an impact on research, through demonstrating that participants' verbal accounts of shock while viewing the intervention translates to a physiological increase in the stress response.

Qualitative and quantitative findings were combined to inform the design of the procedure and implementation of the final larger scale study within the thesis. Albeit opposite of the expected effect, the manipulation of the stress response through the instruction types was successful. Results showed that the stress response was higher in the participants that

received the Reassuring instructions in comparison to the participants that received the Neutral instructions. Therefore, the results confirmed that different levels of stress were induced during the intervention through the devised instruction types. As a differential stress response was still observed, the decision was made to use both types of instructions to manipulate the stress levels induced by the age-progression intervention, in order to investigate the impact of stress on smoking outcomes.

The third and final study undertaken within this thesis was a RCT. The trial design was based on findings from the pilot investigation. The trial aimed to test the efficacy of the age-progression intervention and Control intervention arm, on smoking outcomes over a longitudinal follow up period up to 6-months. The study was also designed to examine the influence of the stress response, through implementation of the aforementioned instruction types and the measurement of stress reactivity. The RCT implemented a three-arm (Control, Neutral and Reassuring arms) randomised through single blind design, in order to reduce the influence of bias on the results to a minimum. A sample of 72 women (18-55 years old), who smoked at the time of the intervention, were equally distributed within each arm of the trial. Participants completed pre-, immediately post-, and at 1-, 3- and 6-months post-intervention questionnaires gathering demographic information, smoking behaviour outcomes and other relevant information (potentially moderating or mediating variables). Before and during the intervention, measurements of subjective and physiological stress were obtained. RCT analysis revealed that the Reassuring arm had significantly higher quit smoking intentions outcomes at 3-months post-intervention in comparison to the Control arm. Also, at 6-months there was significant increase in the number of abstinent participants that received the age-progression intervention, the majority being within the Reassuring arm. The positive changes in smoking outcomes demonstrate effectiveness of the intervention in increasing intention to quit and smoking abstinence. These findings evidence the ability of the intervention to bridge the intention-behaviour gap, achieved through the addition of the Reassuring instruction type.

Another aim of the RCT was to investigate the impact of stress reactivity on the intervention smoking outcomes. Significant differences were observed in the physiological reactivity between the arms, as the Neutral arm demonstrated significantly increased levels of EDA Tonic, than the Control and Reassuring arms at different phases of the intervention or control. The Reassuring instruction arm demonstrated significantly

greater subjective stress in responses to the intervention, and a positive moderation effect of higher levels of subjective stress on quit smoking intentions at 3-months post-intervention. Overall, the results evidenced that stress response to the intervention affected the relationship between the intervention arm and the smoking outcomes. The findings supported the secondary aim of the RCT and clarified the role of stress in the implementation of age-progression interventions.

The use of mixed methods in the empirical work within this thesis through an exploratory sequential approach (Creswell and Creswell, 2018), aided the investigation of the role of stress in the efficacy of the age-progression intervention. Qualitative and quantitative components from the pilot investigation were used to inform and conduct an effective and robust RCT, which enabled the development of original findings.

10.3 Synthesis of the findings

10.3.1 Intervention outcomes

The systematic review, covering the research of the last eight years, indicated that the majority of the facial wrinkling techniques focused on displaying the ageing facial wrinkling effects of smoking on facial skin in order to motivate participants to quit smoking (Burford et al., 2017; Burford et al., 2013; Flett et al., 2017; Song et al., 2013). Out of those studies reviewed, quantitative research that incorporated a strong study design and data collection methods (i.e. the incorporation of control comparison and methods to reduce bias (Burford et al., 2013)), provided strong supporting evidence that appearance-based interventions are effective in changing quit smoking intentions and behaviour. Limitations of the previous research were identified and taken into consideration to strengthen subsequent empirical work within this thesis. The pilot study provided a testing ground for potential protocol improvements. These improvements were identified for their ability to increase the accuracy in testing and measurement of the impact of the intervention on smoking outcomes. One of these identified improvements was to decrease the rates of participant attrition. Within the pilot study, monitoring of participant retention was achieved by assessing the number of participants who did not complete the follow up questionnaires at each longitudinal time point. This monitoring approach identified aspects in the research design that could be improved, to increase chances of questionnaire completion. Among these, one of the main adaptations within the research design included selecting the optimal time to contact participants in order to remind them to complete the questionnaires. This contact aimed to achieve a balance

between prompting participants to respond, whilst not overly influencing measurement reactivity in participants.

Recommendations from health intervention research highlights the importance of pilot studies (Thabane et al., 2019). Pilot investigations have been shown to allow for the preparation of both interventions, and trials for complex behavioural interventions (Arnold et al., 2009). In the context of age-progression interventions for smoking cessation, research has previously been conducted that has provided information for the preparation of the current RCT research. However, advancements in research design still needed to be tested, in order to produce reliable strong supporting evidence for the effectiveness of health interventions. Debate exists as to the most appropriate terminology to use pilot, or feasibility research (Arain et al., 2010). A definition that is often adhered to states pilot research has specific design features that allow for the preparation of subsequent trials, whereas feasibility research only answers questions as to the achievability of the research (Whitehead et al., 2014). The current pilot study was named so for its specific focus on trialling the implementation of measures of the short-term stress response, and different intervention instruction types. As noted above qualitative findings indicated that adding the measurement of physiological stress (i.e. the incorporation of finger electrodes), did not disrupt participants experience of the age-progression intervention. This was a key indication that the research protocol with the inclusion of equipment to measure physiological activity during the intervention could continue, as no evidence of distractions from the intervention were found.

The RCT investigated the implementation of two age-progression intervention arms, versus a Control intervention arm. Instruction types implemented alongside the age-progression intervention included Neutral and Reassuring instructions. The instruction types were designed to manipulate the stress experienced during the age-progression intervention delivery, and tested in the pilot study. Findings from the RCT investigation showed that the Reassuring intervention arm increased quit smoking intentions and 7 day point abstinence rates. Through the previously described protocol development, the RCT implemented a robust methodological design, which indicates findings on the efficacy of the intervention have a reduced chance of bias.

A significant difference in the primary outcome of quit smoking intentions was evidenced between the intervention arms at 3 months post-intervention. The Reassuring instruction

arm displayed increased levels of quit smoking intentions at 3-months post-intervention in comparison to the control intervention arm. Using the same age-progression intervention, Grogan et al. (2011) reported that compared to a control arm, the age-progression intervention increased quit smoking intentions immediately, but not at 1- and 3-months post-intervention delivery, even though decreased levels of nicotine dependence were found at 1-month post-intervention. While both studies report increase in quit smoking intentions, there are some differences regarding the time-points when the differences were observed. In the RCT, significant differences were observed at 3-, but not immediately or at 1-month post-intervention. While Grogan et al. (2011) study found significant differences with the control arm only immediately post-intervention. These differences in time points of findings may be due to the number of trial arms. The present investigation had three arms, in comparison to the two arms presented in Grogan et al's (2011) investigation. Significant differences at immediately and 1-month post-intervention that are present in the two arm design, may not be represented within the three arm trial design used within the thesis, due to the reduced number of participants in each group and corresponding reduction in power (Doostfatemeh et al., 2016). The third arm present in the current research was needed in order to test the initial impact of implementing the instruction types. However, now information is gained as to the impact of these instructions in comparison to the control, future work could look into the use of alternative trial designs such as a two arm trial comparing specific intervention instructions, in order to improve efficiency of the trial.

Other possible explanations for differences in results observed from Grogan et al's (2011 investigation could be the sample characteristics, and interaction with the participants. The Grogan et al. (2011) investigation implemented the intervention among women who were recruited from a quit smoking service. This sample may have displayed greater quit smoking intentions immediately post-intervention delivery, due to an increased motivation to quit in individuals who access quit smoking support (Buczkowski et al., 2014). Whereas, the sample of women in the current RCT were recruited from the general public and did not evidence immediate significant changes in their intentions to quit. In the current sample quit smoking intentions were lower at baseline in all arms compared to Grogan et al's (2011) sample, indicating intervention induced changes may not have reached significant levels of effect as compared to the sample of motivated women previously investigated. Additionally, the previous trial (Grogan et al., 2011), provided a control arm consisting of solely a stop smoking leaflet, whereas due to protocol

developments the present RCT included a control task equivalent in time and interaction with the researcher as in the intervention arms. Increased time with the administrator of an intervention has been evidenced to impact on the results of the intervention (Ockene et al., 1991). Consequently, the current research removed the bias of interaction time, indicating why direct replication of the previous results was not observed.

Despite these differences in sample characteristics and research design, the RCT did display changes in intentions. These increases were observed within the Reassuring arm at the delayed time point of 3 months post- intervention delivery. It is important to note that in the current RCT, the Reassuring arm displayed at baseline (i.e. pre-intervention) significantly less quit smoking intentions than the Control and Neutral arms. This may have influenced the differences that could be observed at later time points in the study, due to measures reaching a ceiling effect in the Neutral and Control arms early on as opposed to the Reassuring. As these arms had higher scores of intentions at pre-intervention, the ability to increase the scores in the immediate (post-intervention) was limited, flagging why no significant differences may be observed at times closer to intervention delivery compared to later time points.

A secondary outcome for the RCT included levels of abstinence, measured at each follow up time point. The results indicated that at 6 months post-intervention, the Reassuring arm had a greater number of participants that were abstinent, in comparison to the other intervention arms. Similar findings have been reported by Burford et al. (2013) who investigated the impact of the same age-progression intervention within a sample identified through community pharmacies. In this study at the 6 months post-intervention time point the intervention arm had a greater number of participants abstinent for a 30 day period. The participant sample included in the Burford et al.'s (2013) investigation mirrors that of the current sample, in terms of age and lower average levels of smoking behaviour. However, Burford et al.'s (2013) recruited both men and women to the study, implementing a two arm design, in which the intervention group received the age-progression intervention in addition to pharmacist delivered stop smoking advice, whereas the control only received advice. This indicates reliable results can be produced in levels of abstinence when the intervention is applied in conjunction with health advice to participants who consumed on average lower amounts of cigarettes (1-5 / day). Despite the comparable results, differences are present in the measures used. The current study measured up to 7 day abstinence, in comparison to Burford et al.'s (2013) 30 day

abstinence. Notwithstanding the differences, both measures of abstinence are considered important and comparable in their measure of smoking outcomes (Cheung et al., 2017).

While both previous RCTs were implemented within a health related setting (pharmacies in (Burford et al., 2013) and stop smoking services in (Grogan et al., 2011)) the current investigation was performed outside of a healthcare context. The results therefore indicate that the impact of the age-progression intervention for smoking cessation on intentions and abstinence may not rely on the location of intervention delivery, or the existing motivation of participants to quit. In addition, the similarity in the findings between all the studies evidences that the Reassuring instruction induced comparable levels of intervention efficacy as non-scripted intervention delivery as used in Grogan et al. (2011) and Burford et al. (2013). Information gained from personal communications with one of the authors (Grogan et al., 2011), suggests that the instructions delivered in previous research may have resembled aspects of the Reassuring intervention arm, over that of the Neutral. The author described how caution was taken to not interfere with the participants experience with the intervention, however some interactions did occur in which the researcher was friendly and calming towards the participant. These small interactions could indicate that unknown to the researcher, the way in which the intervention was delivered may have impacted on the research outcomes. Therefore, an important factor to consider within the age-progression intervention research (and maybe by extension to other health promoting interventions), is the type of interaction that takes place between participant and researcher that could lead to greater efficacy of the intervention.

The age-progression approach can also be viewed as having a similar impact on smoking behaviour, as other available brief smoking interventions. In terms of effect size, in the current investigation, the Reassuring intervention arm displayed a small effect of increasing quit smoking intentions with power to detect the impact, and a large effect on 7 day point abstinence at 6-months. Other brief smoking interventions delivered via physician advice, have been evidenced to create small effects on smoking behaviour when accompanied by the use of additional material and/or follow up appointments (for review and meta-analysis see (Stead et al., 2013)). The current age-progression intervention via Reassuring arm has therefore been indicated to induce the same, if not larger, effect on smoking outcomes in comparison to traditional smoking advice and material. Conversely, interventions that utilise both behavioural and pharmacotherapy approaches, have been shown to produce larger effects on outcomes of smoking at 6 months than the current

investigation (Stead et al., 2016). Interventions of this type are time and resource intensive, whereas interventions such as the age-progression approach can be delivered within one short session and produce increases in motivation to quit. Age-progression can provide impact on smoking cessation on its own, however future research should consider combining the approach with other behaviour and/or pharmacotherapy therapies to support long-term behavioural change.

In summary the work within this thesis included a systematic review that served to identify limitations within previous existing research, and used the knowledge gained to develop and test a new procedure using a pilot study. This allowed the researcher to improve the study design of a final RCT, in order to produce a robust investigation of the efficacy of an age-progression intervention on smoking cessation. The thesis as a whole has therefore clearly demonstrated an advancement in knowledge regarding age-progression intervention implementation and efficacy.

10.3.2 Stress and behaviour change

One particular finding of the previous research surrounding age-progression interventions led to the development of the thesis overall aims and objectives. This finding was reported within qualitative research. Accounts from participants' have repeatedly revealed the theme of a shock response, in reaction to the displayed accelerated effects of smoking on ageing. This was first reported in a sample of women (Grogan et al., 2010b), and later in men (Flett et al., 2017), both samples aged 35 and under. In both instances, the themes of shock were apparent and accompanied by accounts of intentions to change smoking behaviour in reaction to the intervention. Instances of shock has been evidenced to produce similar physiological impacts as both fear and stress (Jang et al., 2015), indicating that the stress response may impact on experiences of the intervention.

Within the thesis pilot study, the mixed methods approach allowed for a qualitative investigation of women's experiences of the intervention. In contrast to previous studies (Flett et al., 2017; Grogan et al., 2010b), women included in this pilot study had an age range between 18-55. Furthermore, the experiences of participants were gathered during both Neutral and Reassuring instruction delivery. The effect of these instructions was captured through both qualitative accounts, and the measurement of psychological (using a self-report Likert scale), and physiological stress (sensors applied to the fingers to measure electrodermal activity and heart rate). As in previous qualitative research on age-

progression for smoking cessation (Grogan, 2017; Grogan et al., 2010b), the shock reaction was a prominent theme within the total sample of 30 women. Furthermore, the shock reaction was consistent with themes across age-progression interventions for sun damage (Williams et al., 2013; Persson et al., 2018a), and alcohol use (Owen et al., 2019). The dominant aspect of shock across a variety of health behaviours implies that the interventions' success relies on its ability to increase perceived threat to the self. Protection Motivation Theory indicates that if threat of a negative health behaviour is perceived to be personal, behaviour change is more likely to occur (Maddux and Rogers, 1983). In the context of the age-progression interventions for smoking cessation, the participant views the projection of their own ageing appearance, directly displaying the threat of smoking to the skin. In the current thesis, shock and threat is implicated in the mechanism of effect in changing smoking behaviour. Participants' accounts indicated that the Reassuring instruction type increased the overall level of shock in comparison to Neutral, suggesting that the efficacy of the age-progression intervention could be increased by delivering the intervention using reassuring statements.

Through measurement of the psychological and physiological stress response during intervention administration, the pilot study was the first of its kind to objectively measure levels of stress (physiological activity), in addition to participant's subjective experience of shock. Consequently, through the two parts of the pilot study (qualitative and quantitative), both shock accounts and stress measures, were found to increase during the administration of the age-progression intervention. Furthermore, the quantitative measures of psychological and physiological stress mirrored those of the subjective shock accounts, as again in the Reassuring instruction condition participants demonstrated an increase in the physiological stress as compared to the Neutral group. Remarkably though, the pilot research seemed to indicate that through adding Reassuring statements to the instructional content it did not, as predicted, calm and reduce stress within participants, but did in fact produce an elevated stress response. Traditionally verbal cues of reassurance have been thought to reduce fear and anxiety specifically in medical settings (Coia and Morley, 1998). However, as discussed in previous chapters a paradoxical effect of reassurance could have been induced in the current research, which has been viewed previously in the context of social support manipulation of physiological stress (Closa León et al., 2007). Without elements of social support, through trying to reassure participants, fear and stress could be increased (McDonald et al., 1996). Although no extensive empirical research has been conducted to support this argument, the

paradoxical effect however does align to Ironic Process Theory (Wegner, 1994) which proposes that deliberate attempts to supress certain thoughts and reactions make them more likely to occur. Additionally, research indicates that when participants are primed to feel anxious, suppression of anxious thoughts often occurs, resulting in increased anxiety and stress (Koster et al., 2003). The impact of reassurance priming is observed when viewed in children awaiting medical treatment, as when indicating to the child that the medical procedure would not hurt, this led to an increased level of distress (McMurtry et al., 2010). Although observed in adults and not children, a similar priming effect may have been created consequently increasing stress and anxiety through reassurance.

The preliminary results regarding the increased stress and shock response within the Reassuring versus Neutral instruction was investigated further within the RCT. The pilot investigation was used to investigate the impact of the instruction types on the stress response to the intervention. While the RCT aimed to investigate the role these instruction types, and corresponding stress response, had on the smoking outcomes of the intervention. Some differences were observed in the physiological stress response elicited by the Neutral and the Reassuring instructions, indicating the Neutral arm had a slight increase in EDA at some phases of the intervention. While subjective measures of stress echo those of previous themes and findings, illustrating a significant increase within the Reassuring arm.

Although subjective and physiological responses were not increased in the same way within the RCT, the differences between these two measures may help to explain the action of the instruction type on smoking outcomes. Stress is increased in both groups from baseline levels, yet unique to the Reassuring arm this increase in stress is accompanied by statements of reassurance. In contrast to the Neutral instructions, the Reassuring instructions provided information and cues to the participants, allowing them to prepare for the visualization of the aged morphed images, and at the same time, providing supporting/encouraging statements that may make the individual feel they could manage the threat. Compared to the Neutral arm, the Reassuring arm increased subjective stress, that could have been induced by the preparedness elicited by the introductory statements (Coia and Morley, 1998), and reduced the physiological stress response, as being comforted and reassured facilitates a faster adaptation to the situation. Therefore, reassuring instructions could differentially have impacted physiological activity (EDA and HR) and primed conscious appraisal of stress (as evidenced by higher

subjective ratings of stress). Interestingly, research on the influence of social support on stress reactivity suggests that the effects of reassurance on physiological reactivity depends on the gender of the person delivering the instructions, with a higher stress reduction being observed when reassurance is provided by women (Glynn et al., 1999), as was the case in this theses. Further research in this area is needed to distinguish the effect of the facilitator and participants in the context of age-progression interventions.

The differences in stress, and corresponding changes between the instruction type conditions, link closely to the Extended Parallel Process model developed by Witte (1994). The theory proposes that when fear messages are in place, there are three possible broad categories of responses. The first category is a *non-response*, experienced when no risk to the self is felt. Second is *danger control,* when an individual responds by taking proactive action to reduce threat to the self. Lastly, *fear control responses* where an individual is solely motived to reduce the level of fear. If the individual perceives that they have enough self-efficacy to reduce the threat presented to them, then *self-danger control* responses will be evoked, in which action will be taken to reduce the threat (Maloney et al., 2011), in this instance reducing smoking behaviour to eliminate the effect of smoking on facial wrinkling. Accordingly, levels of threat and stress were increased in both age-intervention arms, as evidenced by increased levels of physiological stress in comparison to the Control arm. However, as mentioned above, only the Reassuring arm reported increased subjective stress in comparison to the Control arm. It is important to note, that Reassuring statements could have provided the participant an increased sense of belief in their own abilities (self-efficacy) to respond to the danger, and subsequently increase in their intentions to quit smoking and promote abstinence. Therefore, a *Danger control response* could be evoked, which may elicit attention to the stop smoking message promoted by the intervention. A criticism of fear appeal messages is that they could induce avoidance (Ruiter et al., 2014), which indicates parallels can be drawn between the Neutral instructions and traditional fear warnings, as they both could induce high levels of stress and not promote self-efficacy in smokers, creating a *fear control response*. The interpretation of findings has been linked to well established behaviour change theory (EPPM, Witte (2008)). However, more empirical research is needed to identify if as well as stress, self-efficacy plays a substantial role in the success of age-progression interventions.

The importance of interaction of instruction type with stress is demonstrated further with the moderating impact of subjective stress. At high levels only, subjective stress moderated the effect of the intervention on smoking intentions in the Reassuring arm. The moderating action of this subjective stress response could also be attributed to the curvilinear observed trajectory (increase and decrease in response), the stress response was observed to have within the study. Subjective stress was found to immediately increase after intervention administration, before returning to baseline levels within five minutes after the intervention was completed and health information was introduced. Moderately increased short-term stress response has been evidenced to increase working memory capacity (Corbett et al., 2017), while high or sustained levels of acute stress can reduce prefrontal cortex activity producing maladaptive responses to stress (Arnsten and Li, 2005). The curvilinear pattern observed in the current study, (of moderately increased stress and rapid return to baseline after the intervention) could therefore have increased chances of behaviour change acceptance as evidenced in previous research (Dillard et al., 2017). Consequently, induced experiences of optimal levels of short-term stress and memory processing, combined with subsequent reduction in stress in the Reassuring arm, could serve to reduce avoidance of the intervention message, contributing to the significant changes in smoking behaviour.

The results of the thesis concerning the shock and stress response highlight novel insight into the role of stress in behaviour change, specific to the age-progression intervention, but applicable to wider intervention research. Results suggest that stress experienced during the intervention may have a key role in behaviour change. This plausible positive effect of stress is an under researched area, in direct contrast to the wealth of research implicating the negative effect of stress on smoking outcomes, specifically in women (Torres and O'Dell, 2016). The role of qualitative methods, first evidencing the link between the shock and stress response for this specific intervention, highlights the importance of the mixed methods approach in this type of research. The approach allows for the qualitative accounts of participants to lead the investigation, improving intervention delivery for later recipients. Importantly, this research has showed that manipulating the stress response to the age-progression intervention, by means of content of the instructions, has a large impact on the overall outcome of the intervention.

10.4 Strengths

Strengths of the individual components to the thesis have been explored throughout the chapters. The discussion of the overall strengths of the thesis as a whole will be explored below.

One major strength of the thesis as a whole was that the research is the first of its kind to investigate whether the shock reaction, highlighted by qualitative research, could be objectively measured without interference with the intervention procedure, via a mixed methods approach. The objective measure of stress, therefore provided strong evidence to suggest that participants' accounts of shock is accompanied by a physiological reaction elicited by the intervention. This new aspect to the research design implemented and tested suggestions from previous research, which called for the use of physiological measures (Pokharel et al., 2019), to refine our understanding of the mechanisms regarding the effect of stress on behaviour change.

The research therefore, also adds novel contributions to the small area of research that implicates the positive influence of short-term stress on changes in smoking behaviour. Previously research has mostly focused on the impact of fear messages that are designed to induce intense stress (Cho et al., 2018; Droulers et al., 2017; Khandaker and Rana, 2016), which can induce avoidance to the message (Kessels et al., 2014). In contrast, the current research aimed to induce a mild stress, which has previously been overlooked for its impact on behaviour change, and specifically smoking outcomes. Additionally, the research area is predominantly dominated by between group designs (exposed to different stressor conditions), that support the linear model of behaviour change (Dillard et al., 2017). The model implies that when fear or stress is elicited, behaviour change will occur (Tannenbaum et al., 2015). The use of this research design has been criticised, as it only assesses two groups with different levels of stress (Dillard et al., 2017). The current thesis therefore adds strength to the research area, as a linear approach was investigated with a control arm and two age-intervention arms (eliciting a different level of subjective stress), with the arm inducing the greatest stress increase reporting increase quit smoking intentions. Furthermore, a curvilinear approach was also demonstrated, as stress was measured throughout intervention delivery. The RCT findings align with the literature showing that when stress is increased, and later decreased, chances of message acceptance and behaviour change is increased (Dillard et al., 2017). Both of these approaches were

possible to explore, due to the measurement of stress and the between and within group analyses, leading to developments in research design within this narrow field of research.

Researchers have advised that a process of protocol development is needed, in order to assess intended consequences within health based research (Creswell and Creswell, 2018). The complex nature of the pilot investigation included the use of a mixed methods approach. Development of the research protocol was achieved in a comprehensive way through both qualitative and quantitative components (Johnson et al., 2007). The research accomplished the complementary mixed method approach proposed by Greene et al. (1989), as both quantitative and qualitative methods were combined to achieve all aims and objectives set for the pilot study. Without this pragmatic approach (Dures et al., 2011), the integral development of the age-progression intervention protocol would have not been possible.

Lastly, the use of standardised instructions and intervention delivery helped to advance age-progression research. To the author's knowledge, previous research in this area has not stated the use of instruction scripts, therefore the investigator implementing the intervention could have unintentionally favoured, encouraged, or even impaired the efficacy of the intervention, leading to a bias of the findings (Villeval et al., 2019). By implementing standardised instructions, consistency in delivery can be assured, minimising bias in participant interaction. This can lead to more precise and robust investigations of the intervention's impact on smoking behaviour.

10.5 Limitations

Although the implementation of instruction types has been a large advantage to the research design, it did lead to some limitations of the findings. This is the first time where standardised instructions have been implemented to age-progression interventions and the first instance where two instruction sets were created to affect the stress response to the intervention. Due to this, the instructions have been put under limited testing, only with a sample of women, and therefore caution should be taken in the generalisation of the findings. Future research can build on these findings by continuing to develop and investigate instruction differences.

Another limitation with the measurements in this thesis was the time point in which primary and secondary smoking information was gathered. Immediate post-intervention

measures are prone to social desirability bias, in which the participant elevates their responses either consciously or not, to demonstrate change to the researcher (Persoskie and Nelson, 2013). The social desirability effect may also be more apparent during the more social desirability evocative situation of the condition delivery in which the experimenter was present, in comparison to subsequent online assessment used at longitudinal time points (Joinson, 1999). Social desirability could have affected the results at this immediate post-intervention time point, within participants in all three arms of the RCT. Therefore, differences between arms at post-intervention could have been influenced by social desirability. While this limitation is inherent in the research design, the inclusion of a control group allows the investigation of impact on the dependent variables is caused by the intervention or by other extraneous variables.

A further limitation of the research was the sample size of 72 women that did not allow comparison of the intervention effect between menstrual cycle phases. Previous research has reported that the phase of menstrual cycle may impact on women's ability to quit or reduce smoking behaviour (Saladin et al., 2015; Weinberger et al., 2015). Future research should include larger samples that allow for the between groups comparison of menstrual phase, in order to explore the optimal phase for the intervention efficacy.

A limitation that needs to be acknowledged regarding the thesis empirical work is the sample characteristics, which poses a limitation in the generalisation of the results. The sample in both empirical investigations has consisted largely of a population with a majority of young and white participants. Concerted efforts were made to recruit women from a wide range of ages and backgrounds (such as recruiting within a community setting), however bias in recruitment did occur. The face to face experimental nature of the research for the intervention session may have deterred potential participants with demanding work and time commitments from being able to attend an intervention appointment. This is a hurdle faced in lab-based research, future research should consider the incorporation of public involvement in order to inform recruitment strategies.

Additionally, the RCT did not recruit the total number of participants estimated by a priori power calculation (power level of .80, $N = 156$). Research on RCT's often considers the continuation of recruitment and data collection unethical once a clear superiority of a condition is observed within an interim analysis (Kumar and Chakraborty, 2016). Therefore, although the estimated sample size was not met the post-hoc power calculation

(Faul et al., 2007) of the primary outcome variable for a sample size $N = 72$ showed an effect size = .36. The alpha level of this findings is calculated at approximately $\alpha = .76$, indicating the required level of power of $\alpha = .80$ was closely met for the primary outcome analysis. Hence, although the *a priori* estimation of the number of participants was not met, results show reliable information for the effect of the intervention on the primary outcome variable.

10.6 Implications for public health and healthcare practitioners

Smoking is one of the leading causes of preventable mortality and a major driver of health inequality (Office for National Statistics, 2019). Although important progress has been made in reducing tobacco usage (Feliu et al., 2019b), and the political promise of a smoke free UK by 2030 has been made (Office for National Statistics, 2019). Bold and ambitious action is needed to meet this goal, including changes to legislation and universal access to quit smoking support (Department of Health and Social Care, 2019). As discussed in Chapter 2, women specifically have added barriers to smoking cessation including specific health risks (Huxley and Woodward, 2011), and an increased sense of reward from continued smoking (Perkins et al., 2006). Consequently, as the current intervention has been found effective to reduce smoking, and specifically in a sample of women, the age-progression intervention could be considered as an additional strategy to be implemented to aid smoking cessation in the UK.

Traditional health interventions have shown varying success (Michie et al., 2018), yet in light of society's interest in appearance (Grogan, 2017), and new developments in facial morphing technology (Flett et al., 2013; Rajanala et al., 2018), age-progression techniques could be of use as a technique to motivate smokers who appear resistant to previous health based techniques. As such, health practitioners should consider the implementation of age-progression techniques, as this approach has been gaining momentum for a number of years, demonstrated by the current and previous systematic review (Flett et al., 2013), with specific focus on how the intervention approach can benefit women. To support the implementation of this intervention, evidence implicates the cost-effective nature of the approach. In Australia the incremental cost of providing the intervention was calculated at $46 (AU) per abstinent smoker (Burford et al., 2013). In the UK, a case study by Cancer Research UK (2018a) estimates that an individual who smokes costs society around £1,900 a year. By quitting or reducing smoking this cost could be reduced by 50%. Taking the current RCT research as an example, 12.5% of the

remaining participants at 6-months post-intervention reported being abstinent to smoking for at least 7 days. Therefore, for every 100 women administered the intervention there is a chance 12 women could stop or reduce their smoking habits, resulting in a yearly saving of £11,400 a year. The running cost of the intervention could vary depending on software type and use of an intervention administrator, yet overall the intervention is indicated to produce cost benefits to society. Additionally, these benefits could have a roll-on effect on their family due to the reduction in second hand smoke (DiGiacomo et al., 2019) and reduction in smoking as a learnt behaviour in their offspring (Vuolo and Staff, 2013).

With developments in facial ageing technology, alternative software could be explored to maximise ease of use and application of age-progression interventions to a wide range of individuals. When implemented within a community setting to target women from a range of backgrounds and ages, the intervention could be a first step for women to stop smoking. Qualitative findings within this thesis suggest a need for both health and appearance modes of support, hence the intervention could be used to sign post towards more health focused support. Age-progression interventions have been found to impact on a wide range of health behaviours in addition to smoking (Sun damage (Pokharel et al., 2019; Persson et al., 2018b), alcohol usage (Owen et al., 2019)) demonstrating the technique's wide range of applicability within public health, and suggests increased effects could be observed when paired with more intensive support.

The thesis could also be utilised to inform public health campaigns and intervention research. The findings that relate to the stress response highlight the need to be aware of how the participant or patient reacts to health interventions. Most importantly, as demonstrated by the research presented in this thesis, in addition to previous research, stress can be a large factor within message acceptance and behaviour change (Blondé and Girandola, 2018; Dillard et al., 2017). Results from this thesis highlight that a balance of stress and reassurance could be vital for eliciting behaviour change, as supported by the EPP model (Witte, 1994), with optimal levels stress needed in order to increase the level of attention paid to health messages (Ruiter et al., 2014). Existing media stop smoking health campaigns, e.g. those introduced in Greater Manchester have been found effective in some cases (Chung-Hall, 2019). If these messages could be accompanied by inducing the optimal levels of stress and reassurance, as induced in this thesis, the chances of quit attempts and behaviour change could be further increased.

10.7 Future areas of research

The present thesis established a number of novel findings and advancements in the area of age-progression interventions for smoking cessation, and the role of the stress response. Furthermore, areas of future research are also indicated below to inform the subsequent directions of the research in the area.

The first recommendation derived from this thesis is that approaches to smoking cessation should include a combination of health and appearance interventions. The qualitative analyses indicated that women preferred to receive both appearance and health information, related to smoking cessation. As it stands, the experimental design utilised within this thesis included the delivery of a stop smoking leaflet directly after intervention delivery. The stress induced by the age-progression intervention may have increased attentional vigilance to this health message (Blondé and Girandola, 2018), improving chances of individuals acting to change their smoking behaviour. Going forward, age-progression interventions could include this combined approach, and therefore align to the current focus on health consciousness in today's society (Ayo, 2012; Lyons and Chamberlain, 2017), while also providing a novel element of appearance for smoking cessation.

A second recommendation for future research stems from the lack of diversity in the range of age-progression software. The current thesis employs APRIL age software (APRIL Inc, 2018), as it is the only age morphing technology to the authors knowledge that makes clear that the ageing algorithm is based on data from the general population and peer reviewed research. However, as age-progression intervention research progresses and increases in popularity, future research should seek to employ age-progression interventions which are more cost effective and more widely available through apps or similar methods. Previous research centred on smoking prevention, has used apps of a similar nature within both school based and waiting room settings (Brinker et al., 2018b; Brinker et al., 2018a) with success. However, this technology has not been utilised as a stand-alone intervention for current smokers. For an age morphing software to be used as an intervention for health behaviours, evidence needs to be provided as to what data is used to produce ageing algorithms. Research and transparency will help to increase the confidence participants can have that the images being produced showing realistic predictions of ageing and heath behaviours to the face. Therefore, future research could seek to establish if different age-progression software, that are cost effective and widely

available could successfully be used as interventions for smoking cessation, producing equivalent results in terms of smoking cessation.

Lastly, in light of recent global developments centred around the COVID-19 pandemic, the need for effective online stop smoking support has been made evident. Some evidence indicates that smokers may be more vulnerable to the negative effects of the COVID-19 disease (Vardavas and Nikitara, 2020). Because of the available information at the time, Public Health England (2020) have circulated the message that smokers are at increased risk of developing severe symptoms with the COVID-19 virus, leading to a greater need in stop smoking support at this time. The state of emergency at the time of writing this has demonstrated the need for online resources more than ever before, with predictions this trend could continue for the foreseeable future. Therefore, in order to enable smokers to reduce or quit, future research could investigate the efficacy of age-progression interventions delivered online using Reassuring verbal instructions. This would again increase the availability of interventions of this type to smokers from a range of backgrounds and create a cost-effective solution to support smoking cessation.

10.8 Conclusion

This thesis has provided a comprehensive programme of research adding to the literature centred around age-progression interventions. It is the first empirical attempt to measure the stress reactivity of participants while viewing the age-progression intervention and monitor the impact this has on women's smoking cognitions and behaviours over longitudinal time points. The mixed methods approach employed consisted of an updated systematic review, a mixed methods pilot investigation of the intervention and lastly a randomised controlled trial assessing the efficacy of the intervention. The impact of stress on the intervention outcomes has been assessed via measurement of the physiological and subjective stress response. The empirical research combined therefore equated to the recruitment just over 100 women who smoke. Combined, the findings indicate that age-progression interventions for smoking cessation have a positive impact on reducing smoking behaviour in women. Additionally, the findings indicate that short-term stress experienced during intervention delivery, when enhanced and accompanied with reassurance, can increase the effectiveness of the intervention.

This thesis is of theoretical relevance to models of threat and behaviour change in the context of smoking behaviour. The impact of short-term stress on behaviour change has

been extensively explored in the context of age-progression interventions for women. Additionally, findings reported within this thesis have practical relevance to health professionals, through recommendation for the implementation of health interventions and optimal delivery. Although caution to generalise the findings should be considered given the limitations, the current thesis makes substantial contributions to the existing knowledge of smoking cessation interventions and displays novel findings on the impact of the stress response.

References

Abraham, M., Alramadhan, S., Iniguez, C., Duijts, L., Jaddoe, V. W. V., Den Dekker, H. T., Crozier, S., Godfrey, K. M., Hindmarsh, P. and Vik, T. (2017) 'A systematic review of maternal smoking during pregnancy and fetal measurements with meta-analysis.' *PloS ONE*, 12(2) p. e0170946.

Action on Smoking and Health. (2018) *Smoking statistics*. Action on Smoking and Health. [Online] [Accessed on 25th September 2018] https://ash.org.uk/wp-content/uploads/2019/06/Smoking-Statistics-ASH-fact-sheet-November-2018-v2.pdf

Ajzen, I. (1991) 'The theory of planned behavior.' *Organizational Behavior and Human Decision Processes*, 50(2) pp. 179-211.

Akirav, I., Kozenicky, M., Tal, D., Sandi, C., Venero, C. and Richter-Levin, G. (2004) 'A facilitative role for corticosterone in the acquisition of a spatial task under moderate stress.' *Learning & Memory*, 11(2) pp. 188-195.

al'Absi, M. (2006) 'Hypothalamic–Pituitary–Adrenocortical responses to psychological stress and risk for smoking relapse.' *International Journal of Psychophysiology*, 59(3) pp. 218-227.

al'Absi, M., Hatsukami D Fau - Davis, G. L., Davis Gl Fau - Wittmers, L. E. and Wittmers, L. E. (2004) 'Prospective examination of effects of smoking abstinence on cortisol and withdrawal symptoms as predictors of early smoking relapse.' *Drug and Alcohol Dependence*, 73(3) pp. 267-278.

al'Absi, M., Wittmers, L. E., Erickson, J., Hatsukami, D. and Crouse, B. (2003) 'Attenuated adrenocortical and blood pressure responses to psychological stress in ad libitum and abstinent smokers.' *Pharmacology Biochemistry and Behavior*, 74(2) pp. 401-410.

al'Absi, M., Nakajima, M. and Grabowski, J. (2013) 'Stress response dysregulation and stress-induced analgesia in nicotine dependent men and women.' *Biological Psychology*, 93(1) pp. 1-8.

al'Absi, M., Lemieux, A., Westra, R. and Allen, S. (2017) 'Early life adversity influences stress response association with smoking relapse.' *Psychopharmacology*, 234(22) pp. 3375-3384.

Alkhatib, M. N., Holt, R. D. and Bedi, R. (2005) 'Smoking and tooth discolouration: findings from a national cross-sectional study.' *BMC Public Health*, 5(27) p. 27.

Allen, Kennedy, P. J., Cryan, J. F., Dinan, T. G. and Clarke, G. (2014a) 'Biological and psychological markers of stress in humans: focus on the Trier Social Stress Test.' *Neuroscience and Biobehavioral Reviews*, 38, January, pp. 94-124.

Allen, A. M., Oncken, C. and Hatsukami, D. (2014b) 'Women and Smoking: The Effect of Gender on the Epidemiology, Health Effects, and Cessation of Smoking.' *Current Addiction Reports*, 1(1) pp. 53-60.

Allen, A. M., Carlson, S., Eberly, L. E., Hatsukami, D. and Piper, M. E. (2018) 'Use of hormonal contraceptives and smoking cessation: A preliminary report.' *Addictive Behaviors*, 76, January, pp. 236-242.

Allen, A. M., McRae-Clark, A. L., Carlson, S., Saladin, M. E., Gray, K. M., Wetherington, C. L., McKee, S. A. and Allen, S. S. (2016) 'Determining menstrual phase in human biobehavioral research: A review with recommendations.' *Experimental and Clinical Psychopharmacology*, 24(1) pp. 1-11.

Allen, S. S., Allen, A. M. and Pomerleau, C. S. (2009) 'Influence of phase-related variability in premenstrual symptomatology, mood, smoking withdrawal, and smoking behavior during ad libitum smoking, on smoking cessation outcome.' *Addictive Behaviors*, 34(1) pp. 107-111.

Allen, S. S., Hatsukami, D., Christianson, D. and Nelson, D. (1996) 'Symptomatology and energy intake during the menstrual cycle in smoking women.' *Journal of Substance Abuse*, 8(3) pp. 303-319.

Allison, P. D. (2012) 'Handling missing data by maximum likelihood. .' *In SAS Global Forum Statistics and Data Analysis*. USA (Haverford, PA) , 22.04.12.

Amos, A., Greaves, L., Nichter, M. and Bloch, M. (2012) 'Women and tobacco: a call for including gender in tobacco control research, policy and practice.' *Tobacco Control*, 21(2) pp. 236-243.

Appel, D. W. and Aldrich, T. K. (2003) 'Smoking cessation in the elderly.' *Clinics in Geriatric Medicine*, 19(1) pp. 77-100.

APRIL Inc. (2018) 'APRIL® Face Aging Software.' Version 2.7.5. [Software] AprilAge Inc. [Accessed on 24th January 2018]

Arain, M., Campbell, M. J., Cooper, C. L. and Lancaster, G. A. (2010) 'What is a pilot or feasibility study? A review of current practice and editorial policy.' *BMC Medical Research Methodology*, 10, July, pp. 67-67.

Arias-Carrión, O., Stamelou, M., Murillo-Rodríguez, E., Menéndez-González, M. and Pöppel, E. (2010) 'Dopaminergic reward system: a short integrative review.' *International Archives of Medicine*, 3(1) pp. 24-24.

Armijo-Olivo, S., Warren, S. and Magee, D. (2009) 'Intention to treat analysis, compliance, drop-outs and how to deal with missing data in clinical research: a review.' *Physical Therapy Reviews*, 14(1) pp. 36-49.

Armitage, C. J. and Conner, M. (2001) 'Efficacy of the theory of planned behaviour: A meta-analytic review.' *British Journal of Social Psychology*, 40(4) pp. 471-499.

Arnold, D. M., Burns, K. E., Adhikari, N. K., Kho, M. E., Meade, M. O. and Cook, D. J. (2009) 'The design and interpretation of pilot trials in clinical research in critical care.' *Critical Care Medicine*, 37(1 Suppl) pp. 69-74.

Arnsten, A. F. and Li, B. M. (2005) 'Neurobiology of executive functions: catecholamine influences on prefrontal cortical functions.' *Biol Psychiatry*, 57(11) pp. 1377-1384.

Arnsten, A. F. T. (2009) 'Stress signalling pathways that impair prefrontal cortex structure and function.' *Nature reviews. Neuroscience*, 10(6) pp. 410-422.

Ashare, R. L., Lerman, C., Cao, W., Falcone, M., Bernardo, L., Ruparel, K., Hopson, R., Gur, R., Pruessner, J. C. and Loughead, J. (2016) 'Nicotine withdrawal alters neural responses to psychosocial stress.' *Psychopharmacology*, 233(13) pp. 2459-2467.

Asmelash, L. and Ries, B. (2019) *This app shows you what you'll look like as you age*. CNN. [Online] [Accessed on 3rd of May 2019] https://edition.cnn.com/2019/07/16/us/face-app-drake-dwyane-wade-trnd/index.html

Ayo, N. (2012) 'Understanding health promotion in a neoliberal climate and the making of health conscious citizens.' *Critical Public Health*, 22(1) pp. 99-105.

Back, S. E., Waldrop, A. E., Saladin, M. E., Yeatts, S. D., Simpson, A., McRae, A. L., Upadhyaya, H. P., Contini Sisson, R., Spratt, E. G., Allen, J., Kreek, M. J. and Brady, K. T. (2008) 'Effects of gender and cigarette smoking on reactivity to psychological and pharmacological stress provocation.' *Psychoneuroendocrinology*, 33(5) pp. 560-568.

Baldi, E. and Bucherelli, C. (2005) 'The inverted "u-shaped" dose-effect relationships in learning and memory: modulation of arousal and consolidation.' *Nonlinearity in Biology, Toxicology, Medicine*, 3(1) pp. 9-21.

Baron, J. A., Comi Rj Fau - Cryns, V., Cryns V Fau - Brinck-Johnsen, T., Brinck-Johnsen T Fau - Mercer, N. G. and Mercer, N. G. (1995) 'The effect of cigarette smoking on adrenal cortical hormones.' *The Journal of Pharmacology and Experimental Therapeutics*, 272(1) pp. 151-155.

Baron, R. M. and Kenny, D. A. (1986) 'The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations.' *Journal of Personality and Social Psychology*, 51(6) pp. 1173-1182.

Beard, E., Shahab, L., Cummings, D. M., Michie, S. and West, R. (2016) 'New Pharmacological Agents to Aid Smoking Cessation and Tobacco Harm Reduction:

What Has Been Investigated, and What Is in the Pipeline?' *CNS Drugs*, 30(10) pp. 951-983.

Belita, E. and Sidani, S. (2015) 'Attrition in Smoking Cessation Intervention Studies: A Systematic Review.' *Canadian Journal of Nursing Research*, 47(4) pp. 21-40.

Benowitz, N. L. (2009) 'Pharmacology of nicotine: addiction, smoking-induced disease, and therapeutics.' *Annual Review of Pharmacology and Toxicology*, 49(1) pp. 57-71.

Berger, R. (2008) 'The experience of abused women with their children's law guardians.' *Violence Against Women*, 14(1) pp. 71-92.

Berger, R. and Berger, R. (2015) 'Now I see it, now I don't: researcher's position and reflexivity in qualitative research.' *Qualitative Research : QR*, 15(2) pp. 219-234.

Bindu, R., Sharma, M. K., Suman, L. N. and Marimuthu, P. (2011) 'Stress and coping behaviors among smokers.' *Asian Journal of Psychiatry*, 4(2) pp. 134-138.

Bitsika, V., Sharpley, C. F., Sweeney, J. A. and McFarlane, J. R. (2014) 'HPA and SAM axis responses as correlates of self- vs parental ratings of anxiety in boys with an Autistic Disorder.' *Physiology & Behavior*, 127, March pp. 1-7.

Bjelland, I., Dahl Aa Fau - Haug, T. T., Haug Tt Fau - Neckelmann, D. and Neckelmann, D. (2002) 'The validity of the Hospital Anxiety and Depression Scale. An updated literature review.' *Journal of Psychosomatic Research*, 52(0022-3999) pp. 69-77.

Black, N. (1994) 'Experimental and observational methods of evaluation.' *British Medical Journal*, 309(6953) p. 540.

Blondé, J. and Girandola, F. (2018) 'Self-Relevant Threatening Messages Promote Vigilance Toward Coping Information: Evidence of Positive Processing at Attentional Level.' *Social Cognition*, 36(4) pp. 411-441.

Bloom, E. L., Wing, R. R., Kahler, C. W., Thompson, J. K., Meltzer, S., Hecht, J., Minami, H., Price, L. H. and Brown, R. A. (2016) 'Distress Tolerance Treatment for Weight Concern in Smoking Cessation Among Women: The WE QUIT Pilot Study.' *Behavior Modification*, 41(4) pp. 468-498.

Blount, R. L. and Cohen, L. L. (2000) 'The Effects of Parental Reassurance Versus Distraction on Child Distress and Coping During Immunizations AU - Manimala, M. Reena.' *Children's Health Care*, 29(3) pp. 161-177.

Bonett, D. G. and Wright, T. A. (2015) 'Cronbach's alpha reliability: Interval estimation, hypothesis testing, and sample size planning.' *Journal of Organizational Behavior*, 36(1) pp. 3-15.

Borrelli and Mermelstein. (1998) 'The role of weight concern and self-efficacy in smoking cessation and weight gain among smokers in a clinic-based cessation program.' *Addictive Behaviors*, 23(5) pp. 609-622.

Borrelli, B., Bock, B., King, T., Pinto, B. and Marcus, B. H. (1996) 'The impact of depression on smoking cessation in women.' *American Journal of Preventive Medicine*, 12(5) pp. 378-387.

Boster, F., J. and Mongeau, P. (1982) 'Fear-arousing persuasive messages'. *In* Bostrom, R. N. & Westley, B. H.(Eds.).' *In Communication yearbook.* Vol. 8. Newbury Park: Sage, pp. 330–375.

Boucsein, W. (2012) *Electrodermal activity.* Springer Science & Business Media.

Braun, V. and Clarke, V. (2006) 'Using thematic analysis in psychology.' *Qualitative Research in Psychology*, 3(2) pp. 77-101.

Brechan, I. and Kvalem, I. L. (2015) 'Relationship between body dissatisfaction and disordered eating: Mediating role of self-esteem and depression.' *Eating Behaviors*, 17, April, pp. 49-58.

Brinker, T. J., Alfitian, J., Seeger, W., Groneberg, D. A., von Kalle, C., Enk, A. H., Herth, F. J. F., Kreuter, M., Bauer, C. M., Gatzka, M. and Suhre, J. L. (2018a) 'A Face-Aging Smoking Prevention/Cessation Intervention for Nursery School Students in Germany: An Appearance-Focused Interventional Study.' *International Journal of Environmental Research and Public Health*, 15(8) p. 1656.

Brinker, T. J., Brieske, C. M., Esser, S., Klode, J., Mons, U., Batra, A., Rüther, T., Seeger, W., Enk, A. H., von Kalle, C., Berking, C., Heppt, M. V., Gatzka, M. V., Bernardes-Souza, B., Schlenk, R. F. and Schadendorf, D. (2018b) 'A Face-Aging App for Smoking Cessation in a Waiting Room Setting: Pilot Study in an HIV Outpatient Clinic.' *Journal of Medical Internet Research*, 20(8) p. 10976.

Brinker, T. J., Holzapfel, J., Baudson, T. G., Sies, K., Jakob, L., Baumert, H. M., Heckl, M., Cirac, A., Suhre, J. L., Mathes, V., Fries, F. N., Spielmann, H., Rigotti, N., Seeger, W., Herth, F., Groneberg, D. A., Raupach, T., Gall, H., Bauer, C., Marek, P., Batra, A., Harrison, C. H., Taha, L., Owczarek, A., Hofmann, F. J., Thomas, R., Mons, U. and Kreuter, M. (2016) 'Photoaging smartphone app promoting poster campaign to reduce smoking prevalence in secondary schools: the Smokerface Randomized Trial: design and baseline characteristics.' *BMJ Open*, 6(11) p. e014288.

Buchmann, A. F., Laucht, M., Schmid, B., Wiedemann, K., Mann, K. and Zimmermann, U. S. (2010) 'Cigarette craving increases after a psychosocial stress test and is related to cortisol stress response but not to dependence scores in daily smokers.' *Journal of Psychopharmacology*, 24(2) pp. 247-255.

Buczkowski, K., Marcinowicz, L., Czachowski, S. and Piszczek, E. (2014) 'Motivations toward smoking cessation, reasons for relapse, and modes of quitting: Results from a qualitative study among former and current smokers.' *Patient Preference and Adherence*, 8(default) pp. 1353-1363.

Burford, O., Kindarji, S., Parsons, R. and Falcoff, H. (2017) 'Using visual demonstrations in young adults to promote smoking cessation: Preliminary findings from a French pilot study.' *Research in Social & Administrative Pharmacy*, 14(4) pp. 398-400.

Burford, O., Jiwa, M., Carter, O., Parsons, R. and Hendrie, D. (2013) 'Internet-Based Photoaging Within Australian Pharmacies to Promote Smoking Cessation: Randomized Controlled Trial.' *Journal of Medical Internet Research*, 15(3) pp. 34-45.

Bush, T., Lovejoy, J., Javitz, H., Torres, A. J., Wassum, K., Tan, M. M. and Spring, B. (2018) 'Simultaneous vs. sequential treatment for smoking and weight management in tobacco quitlines: 6 and 12 month outcomes from a randomized trial.' *BMC Public Health*, 18(1) p. 678.

Bush, T., Levine, M. D., Deprey, M., Cerutti, B., Zbikowski, S. M., McAfee, T., Mahoney, L. and Beebe, L. (2009) 'Prevalence of Weight Concerns and Obesity Among Smokers Calling a Quitline.' *Journal of Smoking Cessation*, 4(2) pp. 74-78.

Bush, T., Levine, M. D., Beebe, L. A., Cerutti, B., Deprey, M., McAfee, T., Boeckman, L. and Zbikowski, S. (2012) 'Addressing Weight Gain in Smoking Cessation Treatment: A Randomized Controlled Trial.' *American Journal of Health Promotion*, 27(2) pp. 94-102.

Bush, T., Lovejoy, J., Javitz, H., Magnusson, B., Torres, A. J., Mahuna, S., Benedict, C., Wassum, K. and Spring, B. (2016) 'Comparative effectiveness of adding weight control simultaneously or sequentially to smoking cessation quitlines: study protocol of a randomized controlled trial.' *BMC Public Health*, 16(1) pp. 615-615.

Bylund, D. B. (2006) 'Alpha Adrenergic Receptor Agents.' *In* D.M, P. (ed.) *Reference Module in Biomedical Sciences*. Humana Press, pp. 3-21.

Calasanti, T., King, N., Pietilä, I. and Ojala, H. (2016) 'Rationales for Anti-aging Activities in Middle Age: Aging, Health, or Appearance?' *The Gerontologist*, 58(2) pp. 233-241.

Campbell, J. and Ehlert, U. (2012) 'Acute psychosocial stress: does the emotional stress response correspond with physiological responses?' *Psychoneuroendocrinology*, 37(8) pp. 1111-1134.

Cancer Research UK. (2018a) *The Economic Case for Local Investment in Smoking Cessation*. [Online] [Accessed on 3rd August 2020] https://www.cancerresearchuk.org/sites/default/files/economic_case_for_local_investment_in_smoking_cessation_march_2018.pdf

Cancer Research UK. (2018b) *Tobacco statistics*. [Online] [Accessed on 10th February 2019] https://www.cancerresearchuk.org/health-professional/cancer-statistics/risk/tobacco#heading-Zero

Cannon, W. B. (1929) 'Organization for physiological homeostasis.' *Physiological Reviews*, 9(3) pp. 399-431.

Cao, S., Yang, C., Gan, Y. and Lu, Z. (2015) 'The Health Effects of Passive Smoking: An Overview of Systematic Reviews Based on Observational Epidemiological Evidence.' *PLoS ONE*, 10(1) p. e0139907.

Carey, M. P., Kalra, D. L., Carey, K. B. and Halperin, S. (1993) 'Stress and unaided smoking cessation: A prospective investigation.' *Journal of Consulting and Clinical Psychology*, 61(5) pp. 831-838.

Carpenter, M. J., Upadhyaya, H. P., LaRowe, S. D., Saladin, M. E. and Brady, K. T. (2006) 'Menstrual cycle phase effects on nicotine withdrawal and cigarette craving: a review.' *Nicotine & Tobacco Research*, 8(5) pp. 627-638.

Casey, B. J., Getz, S. and Galvan, A. (2008) 'The adolescent brain.' *Developmental Review*, 28(1) pp. 62-77.

Cash, T. F. (2016) 'Multidimensional Body–Self Relations Questionnaire (MBSRQ).' *In* Wade, T. (ed.) *Encyclopedia of Feeding and Eating Disorders*. Singapore: Springer Singapore, pp. 1-4.

Cathain, A., Thomas, K. J., Drabble, S. J., Rudolph, A. and Hewison, J. (2013) 'What can qualitative research do for randomised controlled trials? A systematic mapping review.' *BMJ Open*, 3(6) p. e002889.

Cea-Soriano, L., Garcia Rodriguez, L. A., Machlitt, A. and Wallander, M. A. (2014) 'Use of prescription contraceptive methods in the UK general population: a primary care study.' *Obstetrics & Gynecology*, 121(1) pp. 53-60.

Cepanec, D. and Payne, B. (2000) '"old bags" under the knife: Facial cosmetic surgery amoung women.' *In* Anderson, J. M. S. V. (ed.) *Women's bodies, women's lives*. Toronto: Sumach Press, pp. 121-141.

Chamberlain, K. (2015) *Epistemology and qualitative research.* Qualitative research in clinical and health psychology. Palgrave MacMillan Basingstoke, UK.

Chamberlain, S. R., Müller, U., Blackwell, A. D., Robbins, T. W. and Sahakian, B. J. (2006) 'Noradrenergic modulation of working memory and emotional memory in humans.' *Psychopharmacology (Berl)*, 188(4) pp. 397-407.

Chamik, T., Viswanathan, B., Gedeon, J. and Bovet, P. (2017) 'Associations between psychological stress and smoking, drinking, obesity, and high blood pressure in an upper middle-income country in the African region.' *Stress and Health*, 34(1) pp. 93-101.

Cherrington, A. D. (1999) 'Banting Lecture 1997. Control of glucose uptake and release by the liver in vivo.' *Diabetes*, 48(5) pp. 1198-1214.

Cheung, K. L., de Ruijter, D., Hiligsmann, M., Elfeddali, I., Hoving, C., Evers, S. M. A. A. and de Vries, H. (2017) 'Exploring consensus on how to measure smoking cessation. A Delphi study.' *BMC Public Health*, 17(1) pp. 890-890.

Childs, E. and de Wit, H. (2010) 'Effects of acute psychosocial stress on cigarette craving and smoking.' *Nicotine & Tobacco Research*, 12(4) pp. 449-453.

Cho, Y. J., Thrasher, J. F., Yong, H.-H., Szklo, A. S., O'Connor, R. J., Bansal-Travers, M., Hammond, D., Fong, G. T., Hardin, J. and Borland, R. (2018) 'Path analysis of warning label effects on negative emotions and quit attempts: A longitudinal study of smokers in Australia, Canada, Mexico, and the US.' *Social Science & Medicine*, 197, January, pp. 226-234.

Christensen, J. S., Wild, H., Kenzie, E. S., Wakeland, W., Budding, D. and Lillas, C. (2020) 'Diverse Autonomic Nervous System Stress Response Patterns in Childhood Sensory Modulation.' *Frontiers in Integrative Neuroscience*, 14, Februarry, pp. 6-6.

Chrousos, G. P. (1995) 'The hypothalamic-pituitary-adrenal axis and immune-mediated inflammation.' *The New England Journal of Medicine*, 332(20) pp. 1351-1362.

Chung-Hall, J. (2019) 'Impact of the WHO FCTC over the first decade: a global evidence review prepared for the Impact Assessment Expert Group.' *Tobacco control*, 28(suppl 2) pp. 119-128.

Clarke, L. H. and Korotchenko, A. (2011) 'Aging and the body: A review.' *Canadian Journal on Aging/La Revue canadienne du vieillissement*, 30(3) pp. 495-510.

Closa León, T., Nouwen, A. and Sheffield, D. (2007) 'Social support and individual variability in patterns of haemodynamic reactivity and recovery.' *Psychology & Health*, 22(4) pp. 473-492.

Cohen, S. and Lichtenstein, E. (1990) 'Perceived stress, quitting smoking, and smoking relapse.' *Health Psychology*, 9(4) pp. 466-478.

Cohen, S., Kamarak, T. and Mermelstein, R. (1983) 'A global measure of perceived stress.' *Journal of Health and Social Behavior*, 24(4) pp. 385-396.

Cohen, S., Kamarck, T. and Mermelstein, R. (1994) 'Perceived stress scale.' *Measuring stress: A guide for health and social scientists*, 24 pp. 386-396.

Coia, P. and Morley, S. (1998) 'Medical reassurance and patients' responses.' *Journal of Psychosomatic Research*, 45(5) pp. 377-386.

Conner, M. and Sparks, P. (2005) 'Theory of Planned Behaviour and Health Behaviour.' In Conner, M. and Norman, P. (ed.) *Predicting Health Behaviour*, 2nd ed., UK: Open University Press.

Conner, M. and Norman, P. (2005) *Predicting health behaviour.* 2nd ed., UK: Open University Press.

Copeland, A. L., Martin, P. D., Geiselman, P. J., Rash, C. J. and Kendzor, D. E. (2006) 'Smoking cessation for weight-concerned women: group vs. individually tailored, dietary, and weight-control follow-up sessions.' *Addictive Behaviours*, 31(1) pp. 115-127.

Corbett, B., Weinberg, L. and Duarte, A. (2017) 'The effect of mild acute stress during memory consolidation on emotional recognition memory.' *Neurobiology of Learning and Memory*, 145, November, pp. 34-44.

Courtois, R., Reveilllre, C., Paus, A., Berton, L. and Jouint, C. (2007) 'Links between stress factors, mental health and initial consumption of tobacco and alcohol during pre-adolescence.' *L'Encephale*, 33(3) pp. 300-309.

Crawford, R. (2006) 'Health as a meaningful social practice.' *Health (London)*, 10(4) pp. 401-420.

Creswell, J. W. and Creswell, J. D. (2018) *Research design: qualitative, quantitative and mixed methods approaches.* 5th;International student; ed., Los Angeles: SAGE.

Cronbach, L. J. (1951) 'Coefficient alpha and the internal structure of tests.' *Psychometrika*, 16(3) pp. 297-334.

Cupisti, S., Haberle, L., Dittrich, R., Oppelt, P. G., Reissmann, C., Kronawitter, D., Beckmann, M. W. and Mueller, A. (2010) 'Smoking is associated with increased free testosterone and fasting insulin levels in women with polycystic ovary syndrome, resulting in aggravated insulin resistance.' *Fertility and Sterility*, 94(2) pp. 673-677.

Dagher, A., Tannenbaum, B., Hayashi, T., Pruessner, J. C. and McBride, D. (2009) 'An acute psychosocial stress enhances the neural response to smoking cues.' *Brain Research*, 1293, September, pp. 40-48.

Dani, J. A. and Heinemann, S. (1996) 'Molecular and cellular aspects of nicotine abuse.' *Neuron*, 16(5) pp. 905-908.

Davidson, R. J. (2000) 'Affective style, psychopathology, and resilience: brain mechanisms and plasticity.' *American Psychologist*, 55(11) pp. 1196-1214.

Davis, M. C. (1999) 'Oral contraceptive use and hemodynamic, lipid, and fibrinogen responses to smoking and stress in women.' *Health Psychology*, 18(2) pp. 122-130.

Davis, M. C. and Matthews, K. A. (1990) 'Cigarette smoking and oral contraceptive use influence women's lipid, lipoprotein, and cardiovascular responses during stress.' *Health Psychology*, 9(6) p. 717.

de Kloet, E. R. (2000) 'Stress in the brain.' *European Journal of Pharmacology*, 405(1) pp. 187-198.

de Kloet, E. R., Reul, J. M. H. M. and Sutanto, W. (1990) 'Corticosteroids and the brain.' *The Journal of Steroid Biochemistry and Molecular Biology*, 37(3) pp. 387-394.

de Kloet, E. R., Oitzl, M. S. and Joëls, M. (1999) 'Stress and cognition: are corticosteroids good or bad guys?' *Trends in neurosciences*, 22(10) pp. 422-426.

de Kloet, E. R., Joëls, M. and Holsboer, F. (2005a) 'Stress and the brain: from adaptation to disease.' *Nature Reviews Neuroscience*, 6(6) pp. 463-475.

de Kloet, E. R., Vreugdenhil, E., Oitzl, M. S. and Joels, M. (1998) 'Brain corticosteroid receptor balance in health and disease.' *Endocrine Review*, 19(3) pp. 269-301.

de Kloet, E. R., Sibug, R. M., Helmerhorst, F. M. and Schmidt, M. (2005b) 'Stress, genes and the mechanism of programming the brain for later life.' *Neuroscience & Biobehavioral Reviews*, 29(2) pp. 271-281.

DeBry, S. C. and Tiffany, S. T. (2008) 'Tobacco-induced neurotoxicity of adolescent cognitive development (TINACD): a proposed model for the development of impulsivity in nicotine dependence.' *Nicotine Tobacco Research*, 10(1) pp. 11-25.

Demierre, M.-F., Brooks, D., Koh, H. K. and Geller, A. C. (1999) 'Public knowledge, awareness, and perceptions of the association between skin aging and smoking.' *Journal of the American Academy of Dermatology*, 41(1) pp. 27-30.

Denscombe, M. (2008) 'Communities of Practice: A Research Paradigm for the Mixed Methods Approach.' *Journal of Mixed Methods Research*, 2(3) pp. 270-283.

Department of Health and Social Care. (2019) *Advancing our health: prevention in the 2020s – consultation document*. GOV.UK. [Online] [Accessed on 26rd July 2019] https://www.gov.uk/government/consultations/advancing-our-health-prevention-in-the-2020s/advancing-our-health-prevention-in-the-2020s-consultation-document

Department of Health UK. (2017) *Towards a Smokefree Generation, A Tobacco Control Plan for England.*: [Online] [Accessed on 20th October 2017] https://www.gov.uk/government/publications/towards-a-smoke-free-generation-tobacco-control-plan-for-england

Deveci, S. E., Deveci, F., Acik, Y. and Ozan, A. T. (2004) 'The measurement of exhaled carbon monoxide in healthy smokers and non-smokers.' *Respiratory Medicine*, 98(6) pp. 551-556.

DiClemente, C. C., Prochaska, J. O., Fairhurst, S. K., Velicer, W. F., Velasquez, M. M. and Rossi, J. S. (1991) 'The process of smoking cessation: an analysis of precontemplation, contemplation, and preparation stages of change.' *Journal of Consulting and Clinical Psychology*, 59(2) pp. 295-304.

DiGiacomo, S., Jazayeri, M.-A., Barua, R. and Ambrose, J. (2019) 'Environmental Tobacco Smoke and Cardiovascular Disease.' *International Journal of Environmental Research and Public Health*, 16(1) pp. 96-96.

Dillard, J. P., Li, R. and Huang, Y. (2017) 'Threat Appeals: The Fear-Persuasion Relationship is Linear and Curvilinear.' *Health Communication*, 32(11) pp. 1358-1367.

Dillard, J. P., Plotnick, C. A., Godbold, L. C., Freimuth, V. S. and Edgar, T. (1996) 'The Multiple Affective Outcomes of AIDS PSAs: Fear Appeals Do More Than Scare People.' *Communication Research*, 23(1) pp. 44-72.

Dionne, M. M. and Davis, C. (2004) 'Body image variability: the influence of body-composition information and neuroticism on young women's body dissatisfaction.' *Body Image*, 1(4) pp. 335-349.

Doberenz, S., Roth, W. T., Wollburg, E., Maslowski, N. I. and Kim, S. (2011) 'Methodological considerations in ambulatory skin conductance monitoring.' *International Journal of Psychophysiology*, 80(2) pp. 87-95.

Dobmeyer, A. C., Peterson, A. L., Runyan, C. R., Hunter, C. M. and Blackman, L. R. (2005) 'Body image and tobacco cessation: Relationships with weight concerns and intention to resume tobacco use.' *Body Image*, 2(2) pp. 187-192.

Docherty, G., McNeill, A., Gartner, C. and Szatkowski, L. (2014) 'Did hardening occur among smokers in England from 2000 to 2010?' *Addiction*, 109(1) pp. 147-154.

Doostfatemeh, M., Taghi Ayatollah, S. M. and Jafari, P. (2016) 'Power and Sample Size Calculations in Clinical Trials with Patient-Reported Outcomes under Equal and Unequal Group Sizes Based on Graded Response Model: A Simulation Study.' *Value in Health*, 19(5) pp. 639-647.

Droulers, O., Gallopel-Morvan, K., Lacoste-Badie, S. and Lajante, M. (2017) 'The influence of threatening visual warnings on tobacco packaging: Measuring the impact of threat level, image size, and type of pack through psychophysiological and self-report methods.' *PloS ONE*, 12(9) p. e0184415.

Dures, E., Rumsey, N., Morris, M. and Gleeson, K. (2011) 'Mixed Methods in Health Psychology:Theoretical and Practical Considerations of the Third Paradigm.' *Journal of Health Psychology*, 16(2) pp. 332-341.

Duskova, M., Simunkova, K., Hill, M., Velikova, M., Kubatova, J., Kancheva, L., Kazihnitkova, H., Hruskovicova, H., Pospisilova, H., Racz, B., Salatova, M.,

Cirmanova, V., Kralikova, E., Starka, L. and Parizek, A. (2012) 'Chronic cigarette smoking alters circulating sex hormones and neuroactive steroids in premenopausal women.' *Physiological Research*, 61(1) pp. 97-111.

Edwards, R. (2019) 'Hardening is dead, long live softening; time to focus on reducing disparities in smoking.' *Tobacco Control*, 29(3) p. 055067.

Ekpu, V. U. and Brown, A. K. (2015) 'The Economic Impact of Smoking and of Reducing Smoking Prevalence: Review of Evidence.' *Tobacco Use Insights*, 8(1) pp. 1-35.

Elgendi, M. (2012) 'On the analysis of fingertip photoplethysmogram signals.' *Current Cardiology Reviews*, 8(1) pp. 14-25.

Emmons, K. M. and Weidner, G. (1988) 'The Effects of Cognitive and Physical Stress on Cardiovascular Reactivity Among Smokers and Oral Contraceptive Users.' *Psychophysiology*, 25(2) pp. 166-171.

Enders, C. K. and Bandalos, D. L. (2001) 'The relative performance of full information maximum likelihood estimation for missing data in structural equation models.' *Structural Equation Modeling*, 8(3) pp. 430-457.

Ernst, M., Pine, D. S. and Hardin, M. (2006) 'Triadic model of the neurobiology of motivated behavior in adolescence.' *Psychological Medicine*, 36(3) pp. 299-312.

Espin, L., Villada, C., Hidalgo, V. and Salvador, A. (2019) 'Effects of sex and menstrual cycle phase on cardiac response and alpha- amylase levels in psychosocial stress.' *Biological Psychology*, 140, January, pp. 141-148.

Faria, B. L., Brieske, C. M., Cosgarea, I., Omlor, A. J., Fries, F. N., de Faria, C. O. M., Lino, H. A., Oliveira, A. C. C., Lisboa, O. C., Klode, J., Schadendorf, D., Bernardes-Souza, B. and Brinker, T. J. (2017) 'A smoking prevention photoageing intervention for secondary schools in Brazil delivered by medical students: protocol for a randomised trial.' *BMJ Open*, 7(12) pp. 398-400.

Faul, F., Erdfelder, E., Lang, A.-G. and Buchner, A. J. B. r. m. (2007) 'G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences.' *Behavior Research Methods*, 39(2) pp. 175-191.

Feliu, A., Fernandez, E., Martinez, C. and Filippidis, F. T. (2019a) 'Are smokers "hardening" or rather "softening"? An ecological and multilevel analysis across 28 European Union countries.' *European Respiratory Journal*, 56(3) p. 1900596.

Feliu, A., Filippidis, F. T., Joossens, L., Fong, G. T., Vardavas, C. I., Baena, A., Castellano, Y., Martínez, C. and Fernández, E. (2019b) 'Impact of tobacco control policies on smoking prevalence and quit ratios in 27 European Union countries from 2006 to 2014.' *Tobacco Control*, 28(1) pp. 101-101.

Ferguson, G. and Phau, I. (2013) 'Adolescent and young adult response to fear appeals in anti-smoking messages.' *Young Consumers*, 14(2) pp. 155-166.

Fetters, M. D., Curry, L. A. and Creswell, J. W. (2013) 'Achieving Integration in Mixed Methods Designs Principles and Practices.' *Health Services Research*, 48(6pt2) pp. 2134-2156.

Field, M. and Duka, T. (2004) 'Cue reactivity in smokers: the effects of perceived cigarette availability and gender.' *Pharmacology Biochemistry and Behavior*, 78(3) pp. 647-652.

Finsterwald, C. and Alberini, C. M. (2014) 'Stress and glucocorticoid receptor-dependent mechanisms in long-term memory: from adaptive responses to psychopathologies.' *Neurobiology of Learning and Memory*, 112, July, pp. 17-29.

Fisher, A. J. and Newman, M. G. (2013) 'Heart rate and autonomic response to stress after experimental induction of worry versus relaxation in healthy, high-worry, and generalized anxiety disorder individuals.' *Biological Psychology*, 93(1) pp. 65-74.

Flett, K., Clark-Carter, D., Grogan, S. and Davey, R. (2013) 'How effective are physical appearance interventions in changing smoking perceptions, attitudes and behaviours? A systematic review.' *Tobacco Control*, 22(2) pp. 74-79.

Flett, K., Grogan, S., Clark-Carter, D., Gough, B. and Conner, M. (2017) 'Male smokers' experiences of an appearance-focused facial-ageing intervention.' *Journal of Health Psychology*, 22(4) pp. 422-433.

Franklin, T. R. and Allen, S. S. (2009) 'Influence of menstrual cycle phase on smoking cessation treatment outcome: a hypothesis regarding the discordant findings in the literature.' *Addiction*, 104(11) pp. 1941-1942.

Frederick, S. L., Reus Vi Fau - Ginsberg, D., Ginsberg D Fau - Hall, S. M., Hall Sm Fau - Munoz, R. F., Munoz Rf Fau - Ellman, G. and Ellman, G. (1998) 'Cortisol and response to dexamethasone as predictors of withdrawal distress and abstinence success in smokers.' *Biological Psychiatry*, 43(7) pp. 525-530.

French, D. P. and Sutton, S. (2010) 'Reactivity of measurement in health psychology: How much of a problem is it? What can be done about it?' *British Journal of Health Psychology*, 15(3) pp. 453-468.

French, S. A. and Jeffery, R. W. (1995) 'Weight concerns and smoking: A literature review1.' *Annals of Behavioral Medicine*, 17(3) pp. 234-244.

Frevert, T. K. and Walker, L. S. (2014) 'Physical Attractiveness and Social Status.' *Sociology Compass*, 8(3) pp. 313-323.

Fulkerson, J. A. and French, S. A. (2003) 'Cigarette smoking for weight loss or control among adolescents: gender and racial/ethnic differences.' *Journal of Adolescent Health*, 32(4) pp. 306-313.

Germeroth, L. J. and Levine, M. D. (2018) 'Postcessation weight gain concern as a barrier to smoking cessation: Assessment considerations and future directions.' *Addictive Behaviors*, 76, January, pp. 250-257.

Ghasemi, A. and Zahediasl, S. (2012) 'Normality tests for statistical analysis: a guide for non-statisticians.' *International Journal of Endocrinology and Metabolism*, 10(2) pp. 486-489.

Giacobbi, P., Hingle, M., Johnson, T., Cunningham, J. K., Armin, J. and Gordon, J. S. (2016) 'See Me Smoke-Free: Protocol for a Research Study to Develop and Test the Feasibility of an mHealth App for Women to Address Smoking, Diet, and Physical Activity.' *Jmir Research Protocols*, 5(1) p. e12.

Gilbert, Meliska Cj Fau - Plath, L. C. and Plath, L. C. (1997) 'Noise stress does not modulate effects of smoking/nicotine on beta-endorphin, cortisol, ACTH, glucose, and mood.' *Psychopharmacology Berl*, 130(3) pp. 197-202.

Gill, P., Stewart, K., Treasure, E. and Chadwick, B. (2008) 'Methods of data collection in qualitative research: interviews and focus groups.' *British Dental Journal* 204, March, pp. 291-295.

Ginty, A. T., Jones, A., Carroll, D., Roseboom, T. J., Phillips, A. C., Painter, R. and de Rooij, S. R. (2014) 'Neuroendocrine and cardiovascular reactions to acute psychological stress are attenuated in smokers.' *Psychoneuroendocrinology*, 48, October, pp. 87-97.

Gjerstad, J. K., Lightman, S. L. and Spiga, F. (2018) 'Role of glucocorticoid negative feedback in the regulation of HPA axis pulsatility.' *Stress (Amsterdam, Netherlands)*, 21(5) pp. 403-416.

Glynn, L., Christenfeld, N. and Gerin, W. (1999) 'Gender, Social Support, and Cardiovascular Responses to Stress.' *Psychosomatic Medicine*, 61(2) pp. 234-242.

Godoy, L. D., Rossignoli, M. T., Delfino-Pereira, P., Garcia-Cairasco, N. and de Lima Umeoka, E. H. (2018) 'A Comprehensive Overview on Stress Neurobiology: Basic Concepts and Clinical Implications.' *Frontiers in Behavioral Neuroscience*, 12, July, pp. 127-127.

Gómez-Amor, J., Martínez-Selva, J., Román, F., Zamora, S. and Sastre, J. (1990) 'Electrodermal activity, hormonal levels and subjective experience during the menstrual cycle.' *Biological Psychology*, 30(2) pp. 125-139.

Gong, F., Castaneda, D., Zhang, X., Stock, L., Ayala, L. and Baron, S. (2012) 'Using the Associative Imagery Technique in Qualitative Health Research: The Experiences of Homecare Workers and Consumers.' *Qualitative Health Research*, 22(10) pp. 1414-1424.

Gordon, J. S., Armin, J., Hingle, M. D., Giacobbi, P., Cunningham, J. K., Johnson, T., Abbate, K., Howe, C. L. and Roe, D. J. (2017) 'Development and evaluation of the See Me Smoke-Free multi-behavioral mHealth app for women smokers.' *Translational Behavioral Medicine*, 7(2) pp. 172-184.

Govind, A. P., Vezina, P. and Green, W. N. (2009) 'Nicotine-induced upregulation of nicotinic receptors: underlying mechanisms and relevance to nicotine addiction.' *Biochemical Pharmacology*, 78(7) pp. 756-765.

Grabe, S., Ward, L. M. and Hyde, J. S. (2008) 'The role of the media in body image concerns among women: a meta-analysis of experimental and correlational studies.' *Psychological Bulletin*, 134(3) pp. 460-476.

Granado-Font, E., Ferré-Grau, C., Rey-Reñones, C., Pons-Vigués, M., Ribera, E. P., Berenguera, A., Barrera-Uriarte, M. L., Basora, J., Valverde-Trillo, A. and Duch, J. (2018) 'Coping strategies and social support in a mobile phone chat app designed to support smoking cessation: qualitative analysis.' *JMIR mHealth and uHealth*, 6(12) p. e11071.

Grassi, G., Seravalle, G., Calhoun, D. A., Bolla, G. and Mancia, G. (1992) 'Cigarette smoking and the adrenergic nervous system.' *Clinical and Experimental Hypertension*, 14(1-2) pp. 251-260.

Greene, J. C. (2008) 'Is Mixed Methods Social Inquiry a Distinctive Methodology?' *Journal of Mixed Methods Research*, 2(1) pp. 7-22.

Greene, J. C., Caracelli, V. J. and Graham, W. F. (1989) 'Toward a Conceptual Framework for Mixed-Method Evaluation Designs.' *Educational Evaluation and Policy Analysis*, 11(3) pp. 255-274.

Groesz, L. M., Levine, M. P. and Murnen, S. K. (2002) 'The effect of experimental presentation of thin media images on body satisfaction: A meta-analytic review.' *International Journal of Eating Disorders*, 31(1) pp. 1-16.

Grogan, S. (2012a) 'Smoking and Body Image.' *In* Cash, T. (ed.) *Encyclopedia of Body Image and Human Appearance*. Vol. 2. Elsevier, pp. 745-750.

Grogan, S. (2012b) 'Body image development in adulthood.' *In* Smolak, C. L. (ed.) *Body image: A handbook of science, practice, and prevention*. New York: Guilford Press, pp. 93-100.

Grogan, S. (2016) 'Smoking and Appearance.' *In* Hall, M., Grogan, S. and Gough, B. (eds.) *Chemically Modified Bodies: The Use of Diverse Substances for Appearance Enhancement*. London: Palgrave Macmillan UK, pp. 111-126.

Grogan, S. (2017) *Body image: understanding body dissatisfaction in men, women and children.* Third ed., London: Routledge, Taylor & Francis Group.

Grogan, S., Fry, G., Gough, B. and Conner, M. (2009) 'Smoking to stay thin or giving up to save face. Young men and women talk about appearance concerns and smoking.' *British Journal of Health Psychology*, 14, January, pp. 175-186.

Grogan, S., Hartley, L., Conner, M., Fry, G. and Gough, B. (2010a) 'Appearance concerns and smoking in young men and women: Going beyond weight control.' *Drugs: Education, Prevention, and Policy*, 17(3) pp. 261-269.

Grogan, S., Flett, K., Clark-Carter, D., Gough, B., Davey, R., Richardson, D. and Rajaratnam, G. (2010b) 'Women smokers' experiences of an age-appearance anti-smoking intervention: A qualitative study.' *British Journal of Health Psychology*, 16(4) pp. 675-689.

Grogan, S., Flett, K., Clark-Carter, D., Conner, M., Davey, R., Richardson, D. and Rajaratnam, G. (2011) 'A randomized controlled trial of an appearance-related smoking intervention.' *Health Psychology*, 30(6) pp. 805-809.

Gu, F., Caporaso, N. E., Schairer, C., Fortner, R. T., Xu, X., Hankinson, S. E., Eliassen, A. H. and Ziegler, R. G. (2013) 'Urinary concentrations of estrogens and estrogen metabolites and smoking in caucasian women.' *Cancer Epidemiology, Biomarkers & Prevention*, 22(1) pp. 58-68.

Gupta, S. K. (2011) 'Intention-to-treat concept: A review.' *Perspectives in Clinical Research*, 2(3) pp. 109-112.

Haigis, M. C. and Yankner, B. A. (2010) 'The aging stress response.' *Molecular cell*, 40(2) pp. 333-344.

Hammond, D. (2011) 'Health warning messages on tobacco products: a review.' *Tobacco Control*, 20(5) pp. 327-337.

Harrison, K., Allen, A. M., Allen, S. and al'Absi, M. (2015) 'Effects of oral contraceptive use on stress response in acute smoking abstinence.' *Drug and Alcohol Dependence*, 146, January, p. e136.

Harwood, G. A., Salsberry, P., Ferketich, A. K. and Wewers, M. E. (2007) 'Cigarette Smoking, Socioeconomic Status, and Psychosocial Factors: Examining a Conceptual Framework.' *Public Health Nursing*, 24(4) pp. 361-371.

Hayes, A. F. (2017) *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach.* Guilford publications.

Hayes, A. F. and Montoya, A. K. (2017) 'A Tutorial on Testing, Visualizing, and Probing an Interaction Involving a Multicategorical Variable in Linear Regression Analysis.' *Communication Methods and Measures*, 11(1) pp. 1-30.

Heatherton, T. F., Kozlowski, L. T., Frecker, R. C. and Fagerström, K. O. (1991) 'The Fagerström Test for Nicotine Dependence: a revision of the Fagerstrom Tolerance Questionnaire.' *British Journal of Addiction*, 86(9) pp. 1119-1127.

Hennink, M. M. (2007) *International focus group research: A handbook for the health and social sciences.* Cambridge University Press.

Hering, D., Somers, V. K., Kara, T., Jazdzewski, K., Jurak, P., Kucharska, W. and Narkiewicz, K. (2008) 'Heightened acute circulatory responses to smoking in women.' *Blood Pressure*, 17(3) pp. 141-146.

Hertzog, M. A. (2008) 'Considerations in determining sample size for pilot studies.' *Research in Nursing & Health*, 31(2) pp. 180-191.

Higbee, K. L. (1969) 'Fifteen years of fear arousal: research on threat appeals: 1953-1968.' *Psychological Bulletin*, 72(6) pp. 426-444.

Hjemdahl, P., Fagius, J., Freyschuss, U., Wallin, B. G., Daleskog, M., Bohlin, G. and Perski, A. (1989) 'Muscle sympathetic activity and norepinephrine release during mental challenge in humans.' *American Journal of Physiology-Endocrinology And Metabolism*, 257(5) pp. 654-664.

Holliday, E. and Gould, T. J. (2016) 'Nicotine, adolescence, and stress: A review of how stress can modulate the negative consequences of adolescent nicotine abuse.' *Neuroscience and biobehavioral reviews*, 65, June, pp. 173-184.

Hosseinpoor, A. R., Parker, L. A., Tursan d'Espaignet, E. and Chatterji, S. (2012) 'Socioeconomic inequality in smoking in low-income and middle-income countries: results from the World Health Survey.' *PloS ONE*, 7(8) p. e42843.

Houghton, C., Murphy, K., Meehan, B., Thomas, J., Brooker, D. and Casey, D. (2017) 'From screening to synthesis: using nvivo to enhance transparency in qualitative evidence synthesis.' *Journal of Clinical Nursing*, 26(5-6) pp. 873-881.

Hovland, C. I., Janis, I. L. and Kelley, H. H. (1953) 'Communication and persuasion; psychological studies of opinion change.' *The American Political Science Review*, 48(2) pp. 600-600.

Huang, C. L., Lin, H. H. and Wang, H. H. (2008) 'Evaluating screening performances of the Fagerstrom tolerance questionnaire, the Fagerstrom test for nicotine dependence and

the heavy smoking index among Taiwanese male smokers.' *Journal of Clinical Nursing*, 17(7) pp. 884-890.

Hughes, J. R., Keely, J. P., Fagerstrom, K. O. and Callas, P. W. (2005) 'Intentions to quit smoking change over short periods of time.' *Addictive Behaviors*, 30(4) pp. 653-662.

Hughes, J. R., Arana, G., Amori, G., Stewart, F. and Workman, R. (1988) 'Effect of tobacco withdrawal on the dexamethasone suppresion test.' *Biological Psychiatry*, 23(1) pp. 96-98.

Hughes, J. R., Keely, J. P., Niaura, R. S., Ossip-Klein, D. J., Richmond, R. L. and Swan, G. E. (2003) 'Measures of abstinence in clinical trials: issues and recommendations.' *Nicotine & Tobacco Research*, 5(1) pp. 13-25.

Huxley, R. R. and Woodward, M. (2011) 'Cigarette smoking as a risk factor for coronary heart disease in women compared with men: a systematic review and meta-analysis of prospective cohort studies.' *Lancet*, 378(9799) pp. 1297-1305.

Hysert, P. E., Giovino, G. A., Cummings, K. M. and Kuo, C. L. (2008) At Face Value: A Survey of Self Image and Health Behaviour. A Survey of Self Image and Health Behaviour. Summary data.

Hysert, P. E., Mirand, A. L., Giovino, G. A., Cummings, K. M. and Kuo, C. L. (2003) '"At face value": Age progression software provides personalized demonstration of the effects of smoking on appearance.' *Tobacco Control*, 12, June, p. 238.

IBM Corporation. (2016) SPSS Statistics. Version 26. [Software] New York: IBM Corporation. [Accessed on 30th September 2017]

Isenberg, N., Silbersweig, D., Engelien, A., Emmerich, S., Malavade, K., Beattie, B., Leon, A. C. and Stern, E. (1999) 'Linguistic threat activates the human amygdala.' *Proceedings of the National Academy of Sciences of the United States of America*, 96(18) pp. 10456-10459.

Izydorczyk, B. and Sitnik-Warchulska, K. (2018) 'Sociocultural Appearance Standards and Risk Factors for Eating Disorders in Adolescents and Women of Various Ages.' *Frontiers in Psychology*, 29(9) pp. 429-429.

Jakobsen, J. C., Gluud, C., Wetterslev, J. and Winkel, P. (2017) 'When and how should multiple imputation be used for handling missing data in randomised clinical trials – a practical guide with flowcharts.' *BMC Medical Research Methodology*, 17(1) p. 162.

Jang, E.-H., Park, B.-J., Park, M.-S., Kim, S.-H. and Sohn, J.-H. (2015) 'Analysis of physiological signals for recognition of boredom, pain, and surprise emotions.' *Journal of Physiological Anthropology*, 34(1) p. 25.

Janis, I. L. and Feshbach, S. (1953) 'Effect of fear-arousing communications.' *The Journal of Abnormal and Social Psychology*, 48(1) pp. 78-92.

Jebb, A. T., Parrigon, S. and Woo, S. E. (2017) 'Exploratory data analysis as a foundation of inductive research.' *Human Resource Management Review*, 27(2) pp. 265-276.

Jefferies, W. M. (1991) 'Cortisol and immunity.' *Medical Hypotheses*, 34(3) pp. 198-208.

Jenkins, J. (2011) 'Yen and Jaffe's Reproductive Endocrinology: Physiology, Pathophysiology and Clinical Management, 5th edition.' *The Obstetrician & Gynaecologist*, 8(3) pp. 201-201.

Jha, P., Chaloupka, F. J., Moore, J., Gajalakshmi, V., Gupta, P. C., Peck, R., Asma, S. and Zatonski, W. (2006) 'Tobacco Addiction.' *In* nd, Jamison, D. T., Breman, J. G., Measham, A. R., Alleyne, G., Claeson, M., Evans, D. B., Jha, P., Mills, A. and Musgrove, P. (eds.) *Disease Control Priorities in Developing Countries*. 2nd ed., New York, Oxford University Press, pp.851-868.

John, U., Meyer, C., Schumann, A., Hapke, U., Rumpf, H. J., Adam, C., Alte, D. and Ludemann, J. (2004) 'A short form of the Fagerstrom Test for Nicotine Dependence and

the Heaviness of Smoking Index in two adult population samples.' *Addictive Behaviors*, 29(6) pp. 1207-1212.

Johnson, R. B. and Onwuegbuzie, A. J. (2004) 'Mixed Methods Research: A Research Paradigm Whose Time Has Come.' *Educational Researcher*, 33(7) pp. 14-26.

Johnson, R. B., Onwuegbuzie, A. J. and Turner, L. A. (2007) 'Toward a Definition of Mixed Methods Research.' *Journal of Mixed Methods Research*, 1(2) pp. 112-133.

Johnson, S. R. (1987) 'The epidemiology and social impact of premenstrual symptoms.' *Clinical Obstetrics and Gynecology*, 30(2) pp. 367-376.

Joinson, A. (1999) 'Social desirability, anonymity, and internet-based questionnaires.' *Behavior Research Methods, Instruments, & Computers*, 31(3) pp. 433-438.

Kacen, L. (2006) 'The times are a changing: understanding qualitative research in ambiguous, conflictual and changing contexts.' *The Qualitative Report*, 11(2) pp. 209-228.

Karekla, M., Panayiotou, G. and Collins, B. N. (2017) 'Predictors of urge to smoke under stressful conditions: An experimental investigation utilizing the PASAT-C task to induce negative affect in smokers.' *Psychology of Addictive Behaviors*, 31(7) pp. 735-743.

Kassel, J. D., Stroud, L. R. and Paronis, C. A. (2003) 'Smoking, stress, and negative affect: Correlation, causation, and context across stages of smoking.' *Psychological Bulletin*, 129(2) pp. 270-304.

Kessels, L. T., Ruiter, R. A. and Jansma, B. M. (2010) 'Increased attention but more efficient disengagement: neuroscientific evidence for defensive processing of threatening health information.' *Health Psychology*, 29(4) pp. 346-354.

Kessels, L. T., Ruiter, R. A., Wouters, L. and Jansma, B. M. (2014) 'Neuroscientific evidence for defensive avoidance of fear appeals.' *International Journal of Psychology* 49(2) pp. 80-88.

Khandaker, S. and Rana, J. (2016) 'Effectiveness of antismoking campaigns using health shock appeals among male university students in Western Australia.' *Family Medicine & Primary Care Review*, 3(3) pp. 253-261.

Kim, K. H., Bang, S. W. and Kim, S. R. (2004) 'Emotion recognition system using short-term monitoring of physiological signals.' *Medical & Biological Engineering & Computing*, 42(3) pp. 419-427.

Kirschbaum, C., Wust S Fau - Strasburger, C. J. and Strasburger, C. J. (1992) ''Normal' cigarette smoking increases free cortisol in habitual smokers.' *Life Sciences*, 50(6) pp. 435-442.

Kitzinger, J. (1995) 'Qualitative research: introducing focus groups.' *British Medical Journal*, 311(7000) pp. 299-302.

Knott, V., Cosgrove, M., Villeneuve, C., Fisher, D., Millar, A. and McIntosh, J. (2008) 'EEG correlates of imagery-induced cigarette craving in male and female smokers.' *Addictive Behaviors*, 33(4) pp. 616-621.

Knuutinen, A., Kokkonen, N., Risteli, J., Vähäkangas, K., Kallioinen, M., Salo, T., Sorsa, T. and Oikarinen, A. (2002) 'Smoking affects collagen synthesis and extracellular matrix turnover in human skin.' *British Journal of Dermatology*, 146(4) pp. 588-594.

Koh, J. S., Kang, H., Choi, S. W. and Kim, H. O. (2002) 'Cigarette smoking associated with premature facial wrinkling: image analysis of facial skin replicas.' *International Journal of Dermatology*, 41(1) pp. 21-27.

Kok, G., Peters, G.-J. Y., Kessels, L. T. E., ten Hoor, G. A. and Ruiter, R. A. C. (2018) 'Ignoring theory and misinterpreting evidence: the false belief in fear appeals.' *Health Psychology Review*, 12(2) pp. 111-125.

Koob, G. and Kreek, M. J. (2007) 'Stress, Dysregulation of Drug Reward Pathways, and the Transition to Drug Dependence.' *The American Journal of Psychiatry*, 164(8) pp. 1149-1159.

Koster, E. H. W., Rassin, E., Crombez, G. and Näring, G. W. B. (2003) 'The paradoxical effects of suppressing anxious thoughts during imminent threat.' *Behaviour Research and Therapy*, 41(9) pp. 1113-1120.

Kotlyar, M., Thuras, P., Hatsukami, D. K. and al'Absi, M. (2017) 'Sex differences in physiological response to the combination of stress and smoking.' *International Journal of Psychophysiology*, 118, August, pp. 27-31.

Kou, H., Su, Y., Bi, T., Gao, X. and Chen, H. (2016) 'Attentional Biases toward Face-Related Stimuli among Face Dissatisfied Women: Orienting and Maintenance of Attention Revealed by Eye-Movement.' *Frontiers in Psychology*, 7, June, pp. 919-919.

Kreibig, S. D. (2010) 'Autonomic nervous system activity in emotion: A review.' *Biological Psychology*, 84(3) pp. 394-421.

Kuipers, M. A. G., Beard, E., West, R. and Brown, J. (2018) 'Associations between tobacco control mass media campaign expenditure and smoking prevalence and quitting in England: a time series analysis.' *Tobacco Control*, 27(4) p. 455.

Kumar, A. and Chakraborty, B. S. (2016) 'Interim analysis: A rational approach of decision making in clinical trial.' *Journal of Advanced Pharmaceutical Technology & Research*, 7(4) pp. 118-122.

Kvetnansky, R., Sabban, E. L. and Palkovits, M. (2009) 'Catecholaminergic systems in stress: structural and molecular genetic approaches.' *Physiological Reviews*, 89(2) pp. 535-606.

Lambert, S. D. and Loiselle, C. G. (2008) 'Combining individual interviews and focus groups to enhance data richness.' *Journal of Advanced Nursing*, 62(2) pp. 228-237.

Lau, A. W., Edelstein, B. A. and Larkin, K. T. (2001) 'Psychophysiological arousal in older adults: a critical review.' *Clinical Psychology Review*, 21(4) pp. 609-630.

Laustiola, K. E., Lassila, R., Kaprio, J. and Koskenvuo, M. (1988) 'Decreased beta-adrenergic receptor density and catecholamine response in male cigarette smokers. A study of monozygotic twin pairs discordant for smoking.' *Circulation*, 78(5) pp. 1234-1240.

Laviolette, S. R. and van der Kooy, D. (2004) 'The neurobiology of nicotine addiction: bridging the gap from molecules to behaviour.' *Nature Reviews Neuroscience*, 5(1) pp. 55-56.

Lazarus, R. S. (1966) *Psychological stress and the coping process.* McGraw-Hill.

Lazarus, R. S. and Eriksen, C. W. (1952) 'Effects of failure stress upon skilled performance.' *Journal of Experimental Psychology*, 43(2) pp. 100-105.

Le Moal, M. (2007) 'Historical approach and evolution of the stress concept: A personal account.' *Psychoneuroendocrinology*, 32, August, pp. 3-9.

Lee, E. H. (2012) 'Review of the psychometric evidence of the perceived stress scale.' *Asian Nursing Research (Korean Soc Nurs Sci)*, 6(4) pp. 121-127.

Lemieux, A. and al'Absi, M. (2016) 'Stress psychobiology in the context of addiction medicine: from drugs of abuse to behavioral addictions.' *Progress in Brain Research*, 223, November, pp. 43-62.

Levine, M. D., Bush, T., Magnusson, B., Cheng, Y. and Chen, X. T. (2013) 'Smoking-Related Weight Concerns and Obesity: Differences Among Normal Weight, Overweight, and Obese Smokers Using a Telephone Tobacco Quitline.' *Nicotine & Tobacco Research*, 15(6) pp. 1136-1140.

Levine, M. P. (2012) 'Media Influences on Female Body Image.' *In* Cash, T. (ed.) *Emcyclopedia of Body Image and Human Appearance*. Vol. 2. Elsevier, pp. 540-546.

Li, C.-s. R. and Sinha, R. (2008) 'Inhibitory control and emotional stress regulation: neuroimaging evidence for frontal-limbic dysfunction in psycho-stimulant addiction.' *Neuroscience and Biobehavioral Reviews*, 32(3) pp. 581-597.

Lim, K. H., Chong, Z., Khoo, Y. Y. and Kaur, J. (2014) 'Parental smoking status, stress, anxiety, and depression are associated with susceptibility to smoking among non-smoking school adolescents in Malaysia.' *Asia-Pacific Journal of Public Health / Asia-Pacific Academic Consortium for Public Health*, 26(5) pp. 81-90.

Lim, K. H., The, C. H., Lim, H. L., Khoo, Y. Y., Lau, K. J., Yy, C., Mohd Ghazalig, S., Kee Cc, C. C., Lim, K. K., Ibrahim, N. and Yusoff, F. M. (2016) 'Reliability and Validity of the Fagerstrom Test for Cigarettes Dependence among Malaysian Adolescents.' *Iranian Journal of Public Health*, 45(1) pp. 104-105.

Lindsay, S. (2019) 'Five Approaches to Qualitative Comparison Groups in Health Research: A Scoping Review.' *Qualitative Health Research*, 29(3) pp. 455-468.

Lisboa, O. C., Bernardes-Souza, B., Xavier, L. E. D. F., Almeida, M. R., Corrêa, P. C. R. P. and Brinker, T. J. (2019) 'A Smoking Prevention Program Delivered by Medical Students to Secondary Schools in Brazil Called "Education Against Tobacco": Randomized Controlled Trial.' *Journal of Medical Internet Research*, 21(2) p. e12854.

Locker, D. (1992) 'Smoking and oral health in older adults.' *Canadian Journal of Public health = Revue Canadienne de Sante Publique*, 83(6) pp. 429-432.

Loos, E. and Ivan, L. (2018) 'Visual Ageism in the Media.' *In* Ayalon, L. and Tesch-Römer, C. (eds.) *Contemporary Perspectives on Ageism*. Vol. 19. Cham: Springer International Publishing, pp. 163-176.

Lovallo, W. R. (2006) 'Cortisol secretion patterns in addiction and addiction risk.' *International Journal of Psychophysiology*, 59(3) pp. 195-202.

Low, E. C., Ong, M. C. and Tan, M. (2004) 'Breath carbon monoxide as an indication of smoking habit in the military setting.' *Singapore Medical Journal*, 45(12) pp. 578-582.

Ludman, E. J., Curry, S. J., Grothaus, L. C., Graham, E., Stout, J. and Lozano, P. (2002) 'Depressive symptoms, stress, and weight concerns among African American and

European American low-income female smokers.' *Psychology of Addictive Behaviors*, 16(1) pp. 68-71.

Lundberg, U. (2005) 'Stress hormones in health and illness: The roles of work and gender.' *Psychoneuroendocrinology*, 30(10) pp. 1017-1021.

Lunt, P. and Livingstone, S. (1996) 'Rethinking the focus group in media and communications research.' *Journal of Communication*, 46(2) pp. 79-98.

Luo, J., Margolis, K. L., Wactawski-Wende, J., Horn, K., Messina, C., Stefanick, M. L., Tindle, H. A., Tong, E. and Rohan, T. E. (2011) 'Association of active and passive smoking with risk of breast cancer among postmenopausal women: a prospective cohort study.' *BMJ (Clinical Research ed.)*, 342, March, pp. d1016-d1016.

Lyons, A. and Chamberlain, K. (2017) 'Critical Health Psychology.' *In The Palgrave Handbook of Critical Social Psychology*. London: Palgrave Macmillan, pp. 533-555.

Macfarlane, D. P., Forbes, S. and Walker, B. R. (2008) 'Glucocorticoids and fatty acid metabolism in humans: fuelling fat redistribution in the metabolic syndrome.' *The Journal of Endocrinology*, 197(2) pp. 189-204.

Maddock, R. J., Buonocore, M. H., Kile, S. J. and Garrett, A. S. (2003) 'Brain regions showing increased activation by threat-related words in panic disorder.' *Neuroreport*, 14(3) pp. 325-328.

Maddux, J. E. and Rogers, R. W. (1983) 'Protection motivation and self-efficacy: A revised theory of fear appeals and attitude change.' *Journal of Experimental Social Psychology*, 19(5) pp. 469-479.

Maglione, M. A., Maher, A. R., Ewing, B., Colaiaco, B., Newberry, S., Kandrack, R., Shanman, R. M., Sorbero, M. E. and Hempel, S. (2017) 'Efficacy of mindfulness meditation for smoking cessation: A systematic review and meta-analysis.' *Addictive Behaviors*, 69, June, pp. 27-34.

Maloney, E. K., Lapinski, M. K. and Witte, K. (2011) 'Fear Appeals and Persuasion: A Review and Update of the Extended Parallel Process Model.' *Social and Personality Psychology Compass*, 5(4) pp. 206-219.

Manning, B. K., Catley D Fau - Harris, K. J., Harris Kj Fau - Mayo, M. S., Mayo Ms Fau - Ahluwalia, J. S. and Ahluwalia, J. S. (2005) 'Stress and quitting among African American smokers.' *Journal of Behavioral Medicine*, 28(4) pp. 325-333.

Maren, S. and Quirk, G. J. (2004) 'Neuronal signalling of fear memory.' *Nature Reviews Neuroscience*, 5(11) pp. 844-852.

Markou, A. (2008) 'Neurobiology of Nicotine Dependence.' *Philosophical Transactions: Biological Sciences*, 363(1507) pp. 3159-3168.

Marks, D. and Yardley, L. (2004) *Research methods for clinical and health psychology.* London: SAGE.

Marquez, C., Poirier, G., Cordero, M., Larsen, M., Groner, A., Marquis, J., Magistretti, P., Trono, D. and Sandi, C. (2013) 'Peripuberty stress leads to abnormal aggression, altered amygdala and orbitofrontal reactivity and increased prefrontal MAOA gene expression.' *Translational Psychiatry*, 3, January, p. e216.

Masson, C. L. and Gilbert, D. G. (1999) 'Cardiovascular and mood responses to quantified doses of cigarette smoke in oral contraceptive users and nonusers.' *Journal of Behavioral Medicine*, 22(6) pp. 589-604.

Maynard, O. M., Munafò, M. R. and Leonards, U. (2013) 'Visual attention to health warnings on plain tobacco packaging in adolescent smokers and non-smokers.' *Addiction*, 108(2) pp. 413-419.

McClernon, F. J., Kozink, R. V. and Rose, J. E. (2008) 'Individual differences in nicotine dependence, withdrawal symptoms, and sex predict transient fMRI-BOLD responses to smoking cues.' *Neuropsychopharmacology*, 33(9) pp. 2148-2157.

McCorry, L. K. (2007) 'Physiology of the autonomic nervous system.' *American Journal of Pharmaceutical Education*, 71(4) pp. 78-78.

McDonald, I. G., Daly, J., Jelinek, V. M., Panetta, F. and Gutman, J. M. (1996) 'Opening Pandora's box: the unpredictability of reassurance by a normal test result.' *British Medical Journal*, 313(7053) pp. 329-332.

McEvoy, P. and Richards, D. (2003) 'Critical realism: a way forward for evaluation research in nursing?' *Journal of Advanced Nursing*, 43(4) pp. 411-420.

McEwen, B. S. (2005) 'Stressed or stressed out: what is the difference?' *Journal of Psychiatry & Neuroscience : JPN*, 30(5) pp. 315-318.

McEwen, B. S. (2006) 'Protective and damaging effects of stress mediators: central role of the brain.' *Dialogues in Clinical Neuroscience*, 8(4) pp. 367-381.

McEwen, B. S. (2007) 'Physiology and Neurobiology of Stress and Adaptation: Central Role of the Brain.' *Physiological Reviews*, 87(3) pp. 873-904.

McEwen, B. S. and Stellar, E. (1993) 'Stress and the individual: mechanisms leading to disease.' *Archives of Internal Medicine*, 153(18) pp. 2093-2101.

McEwen, B. S. and Wingfield, J. C. (2003) 'The concept of allostasis in biology and biomedicine.' *Hormones and Behavior*, 43(1) pp. 2-15.

McEwen, B. S., De Kloet, E. and Rostene, W. (1986) 'Adrenal steroid receptors and actions in the nervous system.' *Physiological Reviews*, 66(4) pp. 1121-1188.

McKee, S. A., Sinha, R., Weinberger, A. H., Sofuoglu, M., Harrison, E. L., Lavery, M. and Wanzer, J. (2011) 'Stress decreases the ability to resist smoking and potentiates smoking intensity and reward.' *J Psychopharmacol*, 25(4) pp. 490-502.

McKee, S. A., Potenza, M. N., Kober, H., Sofuoglu, M., Arnsten, A. F., Picciotto, M. R., Weinberger, A. H., Ashare, R. and Sinha, R. (2015) 'A translational investigation

targeting stress-reactivity and prefrontal cognitive control with guanfacine for smoking cessation.' *Journal of Psychopharmacology*, 29(3) pp. 300-311.

McMaster, C. and Lee, C. (1991) 'Cognitive dissonance in tobacco smokers.' *Addictive Behaviors*, 16(5) pp. 349-353.

McMurtry, C. M., Chambers, C. T., McGrath, P. J. and Asp, E. (2010) 'When "don't worry" communicates fear: Children's perceptions of parental reassurance and distraction during a painful medical procedure.' *PAIN*, 150(1) pp. 52-58.

Mendelson, J. H., Sholar, M. B., Goletiani, N., Siegel, A. J. and Mello, N. K. (2005) 'Effects of low- and high-nicotine cigarette smoking on mood states and the HPA axis in men.' *Neuropsychopharmacology*, 30(9) pp. 1751-1763.

Mendelson, J. H., Goletiani, N., Sholar, M. B., Siegel, A. J. and Mello, N. K. (2008) 'Effects of smoking successive low-and high-nicotine cigarettes on hypothalamic–pituitary–adrenal axis hormones and mood in men.' *Neuropsychopharmacology*, 33(4) p. 749.

Michie, S., Hyder, N., Walia, A. and West, R. (2011) 'Development of a taxonomy of behaviour change techniques used in individual behavioural support for smoking cessation.' *Addictive Behaviors*, 36(4) pp. 315-319.

Michie, S., West, R., Sheals, K. and Godinho, C. A. (2018) 'Evaluating the effectiveness of behavior change techniques in health-related behavior: a scoping review of methods used.' *Translational Behavioral Medicine*, 8(2) pp. 212-224.

Michie, S., Wood, C. E., Johnston, M., Abraham, C., Francis, J. J. and Hardeman, W. (2015) 'Behaviour change techniques: the development and evaluation of a taxonomic method for reporting and describing behaviour change interventions (a suite of five studies involving consensus methods, randomised controlled trials and analysis of qualitative data).' *Health technology assessment (Winchester, England)*, 19(99) pp. 1-188.

Middlekauff, H. R. M. D., Park, J. M. D. and Moheimani, R. S. B. S. (2014) 'Adverse Effects of Cigarette and Noncigarette Smoke Exposure on the Autonomic Nervous System.' *Journal of the American College of Cardiology*, 64(16) pp. 1740-1750.

Millard, L. A. C., Munafò, M. R., Tilling, K., Wootton, R. E. and Davey Smith, G. (2019) 'MR-pheWAS with stratification and interaction: Searching for the causal effects of smoking heaviness identified an effect on facial aging.' *PLoS Genetics*, 15(10) p. e1008353.

Miller, C., Foubert, B., Reardon, J. and Vida, I. (2007) 'Teenagers' response to self- And other-directed anti-smoking messages: A cross-cultural study.' *International Journal of Market Research*, 49(4) pp. 515-533.

Millman, S. (1968) 'Anxiety, comprehension, and susceptibility to social influence.' *Journal of Personality and Social Psychology*, 9(3) pp. 251-256.

Mizes, J. S., Sloan, D. M., Segraves, K., Spring, B., Pingitore, R. and Kristeller, J. (1998) 'The influence of weight-related variables on smoking cessation.' *Behavior Therapy*, 29(3) pp. 371-385.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G. and The, P. G. (2009) 'Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement.' *PLOS Medicine*, 6(7) p. e1000097.

Moher, D., Hopewell, S., Schulz, K. F., Montori, V., Gøtzsche, P. C., Devereaux, P. J., Elbourne, D., Egger, M. and Altman, D. G. (2010) 'CONSORT 2010 Explanation and Elaboration: updated guidelines for reporting parallel group randomised trials.' *BMJ*, 340, February, p. c869.

Mongeau, P. A. (1998) ‘Another look at fear-arousing persuasive appeals’ *In* M. Allen & R. W. Preiss (Eds.) *Persuasion: Advances though meta-analysis*, Cresskill, NJ.: Hampton Press.

Moran, M. D. (2003) 'Arguments for rejecting the sequential Bonferroni in ecological studies.' *Oikos*, 100(2) pp. 403-405.

Morgan, D. L. (1996) *Focus groups as qualitative research.* Vol. 16. Sage publications.

Morrell, H. E. R. and Cohen, L. M. (2006) 'Cigarette Smoking, Anxiety, and Depression.' *Journal of Psychopathology and Behavioral Assessment*, 28(4) pp. 281-295.

Mroz, J. E., Pullen, C. H. and Hageman, P. A. (2018) 'Health and appearance reasons for weight loss as predictors of long-term weight change.' *Health Psychology Open*, 5(2), pp.1-8.

Munafo, M. R., Roberts, N., Bauld, L. and Leonards, U. (2011) 'Plain packaging increases visual attention to health warnings on cigarette packs in non-smokers and weekly smokers but not daily smokers.' *Addiction*, 106(8) pp. 1505-1510.

Nakagawa, S. (2004) 'A farewell to Bonferroni: the problems of low statistical power and publication bias.' *Behavioral Ecology*, 15(6) pp. 1044-1045.

Neuman, W. L. (2014) *Social research methods: qualitative and quantitative approaches.* Pearson new international;Seventh; ed., Harlow, Essex: Pearson.

Ng, D. M. and Jeffery, R. W. (2003) 'Relationships Between Perceived Stress and Health Behaviors in a Sample of Working Adults.' *Health Psychology*, 22(6) pp. 638-642.

NHS. (2018) *Effects of Smoking on the Body*. [Online] [Accessed on 1st January 2020] https://www.nhs.uk/smokefree/why-quit/smoking-health-problems

Niaura, R., Shadel, W. G., Britt, D. M. and Abrams, D. B. (2002) 'Response to social stress, urge to smoke, and smoking cessation.' *Addictive Behaviors*, 27(2) pp. 241-250.

Nowell, L. S., Norris, J. M., White, D. E. and Moules, N. J. (2017) 'Thematic Analysis: Striving to Meet the Trustworthiness Criteria.' *International Journal of Qualitative Methods*, 16(1) pp. 1-13.

Nvivo. (2015) *NVivo qualitative data analysis software*. Version 11. [Software] QSR International. [Accessed on 2nd February 2018]

O'Cathain, A. (2009) 'Editorial: Mixed Methods Research in the Health Sciences: A Quiet Revolution.' *Journal of Mixed Methods Methods Research*, 3(1) pp. 3-6.

O'Connell, N. S., Dai, L., Jiang, Y., Speiser, J. L., Ward, R., Wei, W., Carroll, R. and Gebregziabher, M. (2017) 'Methods for Analysis of Pre-Post Data in Clinical Research: A Comparison of Five Common Methods.' *Journal of Biometrics & Biostatistics*, 8(1) pp. 1-8.

O'Dea, J. (2012) 'Body Image and Self-Esteem.' *In* T.F Cash (ed), *Encyclopedia of Body Image and Human Appearance*, Elsevier Academic Press, pp. 141-147.

O'Donovan, A. and Hughes, B. (2008) 'Factors that moderate the effect of laboratory-based social support on cardiovascular reactivity to stress.' *International Journal of Psychology and Psychological Therapy*, 8(1) pp. 85-102.

Oates, C. (2000) 'The use of focus groups in social science research.' *In Research training for social scientists*. London, Sage, pp. 186-195.

Ockene, J. K., Kristeller, J., Goldberg, R., Amick, T. L., Pekow, P. S., Hosmer, D., Quirk, M. and Kalan, K. (1991) 'Increasing the efficacy of physician-delivered smoking interventions: a randomized clinical trial.' *Journal of General Internal Medicine*, 6(1) pp. 1-8.

Office for National Statistics. (2019) *Statistics on Smoking England, 2019*. [Online] [Accessed on 31st September 2019] https://digital.nhs.uk/data-and-information/publications/statistical/statistics-on-smoking/statistics-on-smoking-england-2018/part-1-smoking-related-ill-health-and-mortality

Office for National Statistics. (2020) *Adult smoking habits in the UK: 2019*. [Online] [Accessed on 4th August 2020] https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandlifeexpectancies/bulletins/adultsmokinghabitsingreatbritain/2019

Olejnik, S. F. and Algina, J. (1984) 'Parametric ANCOVA and the rank transform ANCOVA when the data are conditionally non-normal and heteroscedastic.' *Journal of Educational Statistics*, 9(2) pp. 129-149.

Owen, A. L., Scholtens, K., Grogan, S. and Burgess, I. R. (2019) 'Students' experiences of a facial morphing intervention designed to encourage safer drinking.' *Psychology and Health*, 34(8) pp. 1-12.

Pang, R. D., Andrabi, N. and Leventhal, A. M. (2017) 'Premenstrual Symptoms and Factors Implicated in Smoking Cessation Among Woman Smokers.' *Experimental and Clinical Psychopharmacology*, 25(4) pp. 235-241.

Pauly, J. R., Ullman, E. A. and Collins, A. C. (1988) 'Adrenocortical hormone regulation of nicotine sensitivity in mice.' *Physiology & Behavior*, 44(1) pp. 109-116.

Pearce, M. S. and Hayes, L. (2005) 'Self-reported smoking status and exhaled carbon monoxide: results from two population-based epidemiologic studies in the North of England.' *Chest*, 128(3) pp. 1233-1238.

Perez, G. H., Nicolau, J. C., Romano, B. W. and Laranjeira, R. (2008) 'Depression: A predictor of smoking relapse in a 6-month follow-up after hospitalization for acute coronary syndrome.' *European Journal of Cardiovascular Prevention and Rehabilitation*, 15(1) pp. 89-94.

Perez-Rubio, G., Sansores, R., Ramirez-Venegas, A., Camarena, A., Perez-Rodriguez, M. E. and Falfan-Valencia, R. (2015) 'Nicotine Addiction Development: From Epidemiology to Genetic Factors.' *Revista de Investigación Clínica*, 67(6) pp. 333-343.

Perkins, K. A. (2009) 'Sex differences in nicotine reinforcement and reward: influences on the persistence of tobacco smoking.' *In The motivational impact of nicotine and its role in tobacco use*. New York: Springer, pp. 143-169.

Perkins, K. A., Doyle T Fau - Ciccocioppo, M., Ciccocioppo M Fau - Conklin, C., Conklin C Fau - Sayette, M., Sayette M Fau - Caggiula, A. and Caggiula, A. (2006)

'Sex differences in the influence of nicotine dose instructions on the reinforcing and self-reported rewarding effects of smoking.' *Psychopharmacology (Berl)*, 184(3-4) pp. 600-607.

Perkins, K. A., Marcus, M. D., Levine, M. D., D'Amico, D., Miller, A., Broge, M., Ashcom, J. and Shiffman, S. (2001) 'Cognitive-behavioral therapy to reduce weight concerns improves smoking cessation outcome in weight-concerned women.' *Journal of Consulting and Clinical Psychology*, 69(4) pp. 604-613.

Persoskie, A. and Nelson, W. L. (2013) 'Just blowing smoke? Social desirability and reporting of intentions to quit smoking.' *Nicotine & Tobacco Tesearch*, 15(12) pp. 2088-2093.

Persson, S., Grogan, S., Dhingra, K. and Benn, Y. (2018a) ''It's bit of an eye opener' – A qualitative study of women's attitudes towards tanning, sun protection and a facial morphing intervention.' *Psychology & Health*, 33(3) pp. 381-397.

Persson, S., Benn, Y., Dhingra, K., Clark-Carter, D., Owen Alison, L. and Grogan, S. (2018b) 'Appearance-based interventions to reduce UV exposure: A systematic review.' *British Journal of Health Psychology*, 23(2) pp. 334-351.

Peters, A., Conrad, M., Hubold, C., Schweiger, U., Fischer, B. and Fehm, H. L. (2007) 'The principle of homeostasis in the hypothalamus-pituitary-adrenal system: new insight from positive feedback.' *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*, 293(1) pp. 83-98.

Phan, K. L., Wager, T., Taylor, S. F. and Liberzon, I. (2002) 'Functional neuroanatomy of emotion: a meta-analysis of emotion activation studies in PET and fMRI.' *Neuroimage*, 16(2) pp. 331-348.

Pickworth, W. B., Baumann, M. H., Fant, R. V., Rothman, R. B. and Henningfield, J. E. (1996) 'Endocrine responses during acute nicotine withdrawal.' *Pharmacology Biochemistry and Behavior*, 55(3) pp. 433-437.

Pirie, P. L., McBride, C. M., Hellerstedt, W., Jeffery, R. W., Hatsukami, D., Allen, S. and Lando, H. (1992) 'Smoking cessation in women concerned about weight.' *American Journal of Public Health*, 82(9) pp. 1238-1243.

Pokharel, M., Christy, K. R., Jensen, J. D., Giorgi, E. A., John, K. K. and Wu, Y. P. (2019) 'Do ultraviolet photos increase sun safe behavior expectations via fear? A randomized controlled trial in a sample of U.S. adults.' *Journal of Behavioral Medicine*, 42(3) pp. 401-422.

Polivy, J. and Herman, P. (2007) 'Is the body the self? Women and body image.' *Collegium Antropologicum*, 31(1) pp. 63-67.

Pomerleau, C. S. and Pomerleau, O. F. (1987) 'The effects of a psychological stressor on cigarette smoking and subsequent behavioral and physiological responses.' *Psychophysiology*, 24(3) pp. 278-285.

Pomerleau, C. S., Zucker, A. N. and Stewart, A. J. (2001) 'Characterizing concerns about post-cessation weight gain: results from a national survey of women smokers.' *Nicotine & Tobacco Research*, 3(1) pp. 51-60.

Pomerleau, C. S., Carton, S. M., Lutzke, M. L., Flessland, K. A. and Pomerleau, O. F. (1994) 'Reliability of the Fagerstrom Tolerance Questionnaire and the Fagerstrom Test for Nicotine Dependence.' *Addictive Behaviors*, 19(1) pp. 33-39.

Posada-Quintero, H. F., Florian, J. P., Orjuela-Cañón, A. D. and Chon, K. H. (2018) 'Electrodermal Activity Is Sensitive to Cognitive Stress under Water.' *Frontiers in Physiology*, 8, January, p. 1128.

Powley, T. L. (2013) 'Chapter 34 - Central Control of Autonomic Functions: Organization of the Autonomic Nervous System.' *In* Squire, L. R., Berg, D., Bloom, F. E., du Lac, S., Ghosh, A. and Spitzer, N. C. (eds.) *Fundamental Neuroscience (Fourth Edition)*. San Diego: Academic Press, pp. 729-747.

Public Health England. (2020) *Smokers at greater risk of severe respiratory disease from COVID-19*. [Online] [Accessed on 5th May 2020]

https://www.gov.uk/government/news/smokers-at-greater-risk-of-severe-respiratory-disease-from-covid-19

Quinn, V., Meenaghan, T. and Brannick, T. (1992) 'Fear Appeals: Segmentation is the Way to Go.' *International Journal of Advertising*, 11(4) pp. 355-366.

Radloff, L. S. (1977) 'The CES-D scale: A self-report depression scale for research in the general population.' *Applied Psychological Measurement*, 1(3) pp. 385-401.

Rajanala, S., Maymone, M. B. C. and Vashi, N. A. (2018) 'Selfies-living in the era of filtered photographs.' *JAMA Facial Plastic Surgery*, 20(6) pp. 443-444.

Rankin, C. H., Abrams, T., Barry, R. J., Bhatnagar, S., Clayton, D. F., Colombo, J., Coppola, G., Geyer, M. A., Glanzman, D. L., Marsland, S., McSweeney, F. K., Wilson, D. A., Wu, C.-F. and Thompson, R. F. (2009) 'Habituation revisited: An updated and revised description of the behavioral characteristics of habituation.' *Neurobiology of Learning and Memory*, 92(2) pp. 135-138.

Ratneswaran, C., Chisnall, B., Li, M., Tan, S., Douiri, A., Anantham, D. and Steier, J. (2016) 'Desensitisation to cigarette package graphic health warnings: a cohort comparison between London and Singapore.' *British Medical Journal Open*, 6(10) p. e012693.

Reed, B. G. and Carr, B. R. (2000) 'The Normal Menstrual Cycle and the Control of Ovulation.' *In* Feingold, K. R., Anawalt, B., Boyce, A., Chrousos, G., Dungan, K., Grossman, A., Hershman, J. M., Kaltsas, G., Koch, C., Kopp, P., Korbonits, M., McLachlan, R., Morley, J. E., New, M., Perreault, L., Purnell, J., Rebar, R., Singer, F., Trence, D. L., Vinik, A. and Wilson, D. P. (eds.) *Endotext*. South Dartmouth (MA): MDText.com, Inc,

Reisner, A., Shaltis, P. A., McCombie, D. and Asada, H. H. (2008) 'Utility of the photoplethysmogram in circulatory monitoring.' *Anesthesiology: The Journal of the American Society of Anesthesiologists*, 108(5) pp. 950-958.

Ressler, K. J. (2010) 'Amygdala Activity, Fear, and Anxiety: Modulation by Stress.' *Biological Psychiatry*, 67(12) pp. 1117-1119.

Richards, J. M., Stipelman, B. A., Bornovalova, M. A., Daughters, S. B., Sinha, R. and Lejuez, C. W. (2011) 'Biological mechanisms underlying the relationship between stress and smoking: State of the science and directions for future work.' *Biological Psychology*, 88(1) pp. 1-12.

Riddle, P. J., Newman-Norlund, R. D., Baer, J. and Thrasher, J. F. (2016) 'Neural response to pictorial health warning labels can predict smoking behavioral change.' *Social Cognitive and Affective Neuroscience*, 11(11) pp. 1802-1811.

Riley, S., Evans, A. and Robson, M. (2018) *Postfeminism and health: Critical psychology and media perspectives.* 1 ed., London: Routledge.

Robinson, A. M. (2018) 'Let's Talk about Stress: History of Stress Research.' *Review of General Psychology*, 22(3) pp. 334-342.

Robinson, S. F., Grun, E. U., Pauly, J. R. and Collins, A. C. (1996) 'Changes in sensitivity to nicotine and brain nicotinic receptors following chronic nicotine and corticosterone treatments in mice.' *Pharmacology Biochemistry and Behavior*, 54(3) pp. 587-593.

Robles, Z., Garey, L., Hogan, J., Bakhshaie, J., Schmidt, N. B. and Zvolensky, M. J. (2016) 'Examining an Underlying Mechanism between Perceived Stress and Smoking Cessation-Related Outcomes.' *Addictive Behaviors*, 58, July, pp. 149-154.

Rohleder, N. and Kirschbaum, C. (2006) 'The hypothalamic-pituitary-adrenal (HPA) axis in habitual smokers.' *International Journal of Psychophysiology*, 59(3) pp. 236-243.

Roockley, C. E. (2014) *A mixed methods obesity prevention intervention for australian children aged 6-12 years: influence of parents misperceptions about food and exercise on the efficacy of educational obesity simulations.* Ph.D,. Edith Cowan University.

Rose, J. E., Ananda, S. and Jarvik, M. E. (1983) 'Cigarette smoking during anxiety-provoking and monotonous tasks.' *Addictive Behaviors*, 8(4) pp. 353-359.

Rosenthal, L., Carroll-Scott, A., Earnshaw, V. A., Sackey, N., O'Malley, S. S., Santilli, A. and Ickovics, J. R. (2013) 'Targeting cessation: Understanding barriers and motivations to quitting among urban adult daily tobacco smokers.' *Addictive Behaviors*, 38(3) pp. 1639-1642.

Rowe, D. J., Dunn, J. R. and Muntaner, C. (2015) 'The impact of job strain on smoking cessation and relapse in the Canadian population: A cohort study.' *Journal of Epidemiology and Community Health*, 69(10) pp. 931-936.

Roy, M. P., Steptoe, A. and Kirschbaum, C. (1994) 'Association between smoking status and cardiovascular and cortisol stress responsivity in healthy young men.' *International Journal of Behavioral Medicine*, 1(3) pp. 264-283.

Ruiter, R. A. C., Kessels, L. T. E., Peters, G.-J. Y. and Kok, G. (2014) 'Sixty years of fear appeal research: Current state of the evidence.' *International Journal of Psychology*, 49(2) pp. 63-70.

Russell, M. A. H. (1980) 'Nicotine intake and its regulation.' *Journal of Psychosomatic Research*, 24(5) pp. 253-264.

Sakai, H. and Ohashi, K. (2013) 'Association of menstrual phase with smoking behavior, mood and menstrual phase-associated symptoms among young Japanese women smokers.' *BioMed Central Women's Health*, 13, March, pp. 10-10.

Saladin, M. E., Gray, K. M., Carpenter, M. J., LaRowe, S. D., DeSantis, S. M. and Upadhyaya, H. P. (2012) 'Gender Differences in Craving and Cue Reactivity to Smoking and Negative Affect/Stress Cues.' *The American Journal on Addictions*, 21(3) pp. 210-220.

Saladin, M. E., Wray, J. M., Carpenter, M. J., McClure, E. A., LaRowe, S. D., Upadhyaya, H. P. and Gray, K. M. (2015) 'Menstrual cycle phase effects in the gender

dimorphic stress cue reactivity of smokers.' *Nicotine Tobacco Research*, 17(5) pp. 607-611.

Sandberg, A., Sköld, C. M., Grunewald, J., Eklund, A. and Wheelock, Å. M. (2011) 'Assessing recent smoking status by measuring exhaled carbon monoxide levels.' *PloS ONE*, 6(12) pp. e28864-e28864.

Sandoz, E. K., Wilson, K. G., Merwin, R. M. and Kellum, K. K. (2013) 'Assessment of body image flexibility: the body image-acceptance and action questionnaire.' *Journal of Contextual Behavioral Science*, 2(1-2) pp. 39-48.

Saquib, N., Papon, M. T. I., Ahmad, I. and Rahman, A. (2015) 'Measurement of heart rate using photoplethysmography.' *In 2015 International Conference on Networking Systems and Security (NSysS)*. Dhaka, Bangladesh, 5-7 Jan. 2015. pp. 1-6.

Schane, R. E., Glantz, S. A. and Ling, P. M. (2009) 'Social smoking implications for public health, clinical practice, and intervention research.' *American journal of preventive medicine* 37(2) pp. 124-131.

Schane, R. E., Ling, P. M. and Glantz, S. A. (2010) 'Health Effects of Light and Intermittent Smoking: A review.' *Circulation*, 121(13) pp. 1518-1522.

Schechter, D., Moser, D., Paoloni-Giacobino, A., Stenz, L., Gex-Fabry, M., Aue, T., Adouan, W., Cordero, M., Suardi, F., Manini, A., Rossignol, A., Merminod, G., Ansermet, F., Dayer, A. and Rusconi Serpa, S. (2015) 'Methylation of NR3C1 is related to maternal PTSD, parenting stress and maternal medial prefrontal cortical activity in response to child separation among mothers with histories of violence exposure.' *Frontiers in Psychology*, 6, May, p. 690.

Schiller, C. E., Saladin, M. E., Gray, K. M. and Hartwell, K. J. (2012) 'Association between ovarian hormones and smoking behavior in women.' *Experimental and Clinical Psychopharmacology*, 20(4) pp. 251-257.

Schmidt, C. A., Romine, J. K., Bell, M. L., Armin, J. and Gordon, J. S. (2017) 'User Participation and Engagement With the See Me Smoke-Free mHealth App: Prospective Feasibility Trial.' *Jmir Mhealth and Uhealth*, 5(10) p. e142.

Schubert, C., Lambertz, M., Nelesen, R. A., Bardwell, W., Choi, J. B. and Dimsdale, J. E. (2009) 'Effects of stress on heart rate complexity—A comparison between short-term and chronic stress.' *Biological Psychology*, 80(3) pp. 325-332.

Schulkin, J., McEwen, B. S. and Gold, P. W. (1994) 'Allostasis, amygdala, and anticipatory angst.' *Neuroscience & Biobehavioral Reviews*, 18(3) pp. 385-396.

Scott, D. (2007) 'Resolving the quantitative–qualitative dilemma: a critical realist approach.' *International Journal of Research & Method in Education*, 30(1) pp. 3-17.

Selye, H. (1936) 'A syndrome produced by diverse nocuous agents.' *Nature*, 138(32) p. 32.

Selye, H. (1950) *The physiology and pathology of exposure to stress.* Acta, Inc.

Shadel, W. G. and Mermelstein, R. J. (1993) 'Cigarette smoking under stress: The role of coping expectancies among smokers in a clinic-based smoking cessation program.' *Health Psychology*, 12(6) pp. 443-450.

Sheeran, P. and Webb, T. L. (2016) 'The intention–behavior gap.' *Social and Personality Psychology Compass*, 10(9) pp. 503-518.

Shiffman, S., Hickcox, M., Paty, J. A. and Gnys, M. (1996) 'Progression from a smoking lapse to relapse: Prediction from abstinence violation effects, nicotine dependence, and lapse characteristics.' *Journal of Consulting and Clinical Psychology*, 64(5) pp. 993-1002.

Shorrock, P. and Bakerly, N. (2019) 'Effects of smoking on health and anaesthesia.' *Anaesthesia & Intensive Care Medicine*, 20(2) pp. 95-97.

Siahpush, M. and Carlin, J. B. (2006) 'Financial stress, smoking cessation and relapse: Results from a prospective study of an Australian national sample.' *Addiction*, 101(1) pp. 121-127.

Siegel, A., Korbman, M. and Erblich, J. (2017) 'Direct and Indirect Effects of Psychological Distress on Stress-Induced Smoking.' *Journal of Studies on Alcohol and Drugs*, 78(6) pp. 930-937.

Skov-Ettrup, L. S., Egan, K. K., Dalum, P. and Tolstrup, J. S. (2017) 'Stress-related expectations about smoking cessation and future quit attempts and abstinence - a prospective study in daily smokers who wish to quit.' *Preventive Medicine Reports*, 6 , June, pp. 187-190.

Slopen, N., Kontos, E. Z., Ryff, C. D., Ayanian, J. Z., Albert, M. A. and Williams, D. R. (2013) 'Psychosocial stress and cigarette smoking persistence, cessation, and relapse over 9–10 years: a prospective study of middle-aged adults in the United States.' *Cancer Causes & Control*, 24(10) pp. 1849-1863.

Smith, J. and Noble, H. (2014) 'Bias in research.' *Evidence Based Nursing*, 17(4) p. 100.

Smith, J. A. (2015) *Qualitative Psychology: A Practical Guide to Research Methods.* 3rd ed., Los Angeles: SAGE.

Smith, P. H., Bessette, A. J., Weinberger, A. H., Sheffer, C. E. and McKee, S. A. (2016) 'Sex/gender differences in smoking cessation: A review.' *Preventive Medicine*, 92, November, pp. 135-140.

Smith, P. H., Kasza, K. A., Hyland, A., Fong, G. T., Borland, R., Brady, K., Carpenter, M. J., Hartwell, K., Cummings, K. M. and McKee, S. A. (2015) 'Gender Differences in Medication Use and Cigarette Smoking Cessation: Results From the International Tobacco Control Four Country Survey.' *Nicotine & Tobacco Research*, 17(4) pp. 463-472.

Sommerfeldt, S. L., Schaefer, S. M., Brauer, M., Ryff, C. D. and Davidson, R. J. (2019) 'Individual Differences in the Association Between Subjective Stress and Heart Rate

Are Related to Psychological and Physical Well-Being.' *Psychological Science*, 30(7) pp. 1016-1029.

Song, F., Elwell-Sutton, T. and Naughton, F. (2018) 'Impact of the NHS stop smoking services on smoking prevalence in England: a simulation modelling evaluation.' *Tobacco Control*, 29(1) pp. 200-206.

Song, H., Kim, J., Kwon, R. J. and Jung, Y. (2013) 'Anti-smoking educational game using avatars as visualized possible selves.' *Computers in Human Behavior*, 29(5) pp. 2029-2036.

Spears, C. A., Bell, S. A., Scarlett, C. A., Anderson, N. K., Cottrell-Daniels, C., Lotfalian, S., Bandlamudi, M., Grant, A., Sigurdardottir, A. and Carter, B. P. (2019) 'Text Messaging to Enhance Mindfulness-Based Smoking Cessation Treatment: Program Development Through Qualitative Research.' *JMIR mHealth and uHealth*, 7(1) p. e11246.

Spradley, J. P. (2016) *The Ethnographic Interview.* Belmont, CA: Waveland Press.

Stavem, K., Rogeberg, O. J., Olsen, J. A. and Boe, J. (2008) 'Properties of the Cigarette Dependence Scale and the Fagerstrom Test of Nicotine Dependence in a representative sample of smokers in Norway.' *Addiction*, 103(9) pp. 1441-1449.

Stead, L. F., Koilpillai, P., Fanshawe, T. R. and Lancaster, T. (2016) 'Combined pharmacotherapy and behavioural interventions for smoking cessation.' *Cochrane Database of Systematic Reviews*, (3) March, pp. 1465-1858.

Stead, L. F., Buitrago, D., Preciado, N., Sanchez, G., Hartmann-Boyce, J. and Lancaster, T. (2013) 'Physician advice for smoking cessation.' *Cochrane Database Systematic Reviews*, (5) May, pp. 000-165.

Steimer, T. (2002) 'The biology of fear- and anxiety-related behaviors.' *Dialogues in Clinical Neuroscience*, 4(3) pp. 231-249.

Steinberg, L. (2010) 'A behavioral scientist looks at the science of adolescent brain development.' *Brain and Cognition*, 72(1) pp. 160-164.

Stephenson, J. and Imrie, J. (1998) 'Why do we need randomised controlled trials to assess behavioural interventions?' *British Medical Journal*, 316(7131) pp. 611-613.

Stewart, D. W. and Shamdasani, P. N. (2014) *Focus groups: Theory and practice.* Third ed, SAGE, Thousand Oaks, California.

Straneva, P., Hinderliter, A., Wells, E., Lenahan, H. and Girdler, S. (2000) 'Smoking, oral contraceptives, and cardiovascular reactivity to stress.' *Obstetrics & Gynecology*, 95(1) pp. 78-83.

Sutton, S. and Hallett, R. (1988) 'Understanding the effects of fear-arousing communications: The role of cognitive factors and amount of fear aroused.' *Journal of Behavioral Medicine*, 11(4) pp. 353-360.

Sweethearts®, S. (2017): [Online] [Accessed 12th February 2018] https://www.socialsweethearts.de/en_US/

Tan, M. M., Okuyemi, K. S., Resnicow, K., Dietz, N. A., Antoni, M. H. and Webb Hooper, M. (2018) 'Association between smoking cessation and weight gain in treatment-seeking African Americans.' *Addictive Behaviors*, 81, June, pp. 84-90.

Tannenbaum, M. B., Hepler, J., Zimmerman, R. S., Saul, L., Jacobs, S., Wilson, K. and Albarracin, D. (2015) 'Appealing to fear: A meta-analysis of fear appeal effectiveness and theories.' *Psychological Bulletin*, 141(6) pp. 1178-1204.

Tashakkori, A. and Creswell, J. W. (2007) 'The New Era of Mixed Methods.' *Journal of Mixed Methods Methods Research*, 1(1) pp. 3-7.

Tennant, F. (2013) 'The physiologic effects of pain on the endocrine system.' *Pain and Therapy*, 2(2) pp. 75-86.

Thabane, L., Cambon, L., Potvin, L., Pommier, J., Kivits, J., Minary, L., Nour, K., Blaise, P., Charlesworth, J., Alla, F. and Discussion Panel. (2019) 'Population health intervention research: what is the place for pilot studies?' *Trials*, 20(1) p. 309.

Thomas, B. H., Ciliska, D., Dobbins, M. and Micucci, S. (2004) 'A Process for Systematically Reviewing the Literature: Providing the Research Evidence for Public Health Nursing Interventions.' *Worldviews on Evidence-Based Nursing*, 1(3) pp. 176-184.

Tomko, R. L., Saladin, M. E., Baker, N. L., McClure, E. A., Carpenter, M. J., Ramakrishnan, V. R., Heckman, B. W., Wray, J. M., Foster, K. T., Tiffany, S. T., Metts, C. L. and Gray, K. M. (2018) 'Sex Differences in Subjective and Behavioral Responses to Stressful and Smoking Cues Presented in the Natural Environment of Smokers.' *Nicotine & Tobacco Research*, 22(1) pp. 81-88.

Tong, C., Bovbjerg, D. H. and Erblich, J. (2007) 'Smoking-related videos for use in cue-induced craving paradigms.' *Addictive Behaviors*, 32(12) pp. 3034-3044.

Torchalla, I., Okoli, C. T. C., Bottorff, J. L., Qu, A., Poole, N. and Greaves, L. (2012) 'Smoking Cessation Programs Targeted to Women: A Systematic Review.' *Women & Health*, 52(1) pp. 32-54.

Torres, O. V. and O'Dell, L. E. (2016) 'Stress is a principal factor that promotes tobacco use in females.' *Progress in Neuropsychopharmacology & Biological Psychiatry*, 65 pp. 260-268.

Tsourtos, G. and O'Dwyer, L. (2008) 'Stress, stress management, smoking prevalence and quit rates in a disadvantaged area: has anything changed?' *Health Promotion Journal of Australia*, 19(1) pp. 40-44.

Tsuda, A., Steptoe, A., West, R., Fieldman, G. and Kirschbaum, C. (1996) 'Cigarette smoking and psychophysiological stress responsiveness: effects of recent smoking and temporary abstinence.' *Psychopharmacology*, 126(3) pp. 226-233.

Tudor-Sfetea, C., Rabee, R., Najim, M., Amin, N., Chadha, M., Jain, M., Karia, K., Kothari, V., Patel, T. and Suseeharan, M. (2018) 'Evaluation of two mobile health apps in the context of smoking cessation: qualitative study of cognitive behavioral therapy (CBT) versus non-CBT-based digital solutions.' *JMIR mHealth and uHealth*, 6(4) p. e98.

Ussher, M., Aveyard, P., Reid, F., West, R., Evans, P., Clow, A., Hucklebridge, F., Fuller, J., Ibison, J. and Steptoe, A. (2011) 'A randomised placebo-controlled trial of oral hydrocortisone for treating tobacco withdrawal symptoms.' *Psychopharmacology*, 216(1) pp. 43-51.

Uysal, M. A., Kadakal, F., Karsidag, C., Bayram, N. G., Uysal, O. and Yilmaz, V. (2004) 'Fagerstrom test for nicotine dependence: reliability in a Turkish sample and factor analysis.' *Tuberk Toraks*, 52(2) pp. 115-121.

Vardavas, C. I. and Nikitara, K. (2020) 'COVID-19 and smoking: A systematic review of the evidence.' *Tobacco Induced Diseases*, 18(20), doi:10.18332/tid/119324.

Vasthare, R., Kumar, S. and Arron, L. (2018) 'Carbon monoxide breath analyzers and its role in tobacco cessation: A narrative review of literature.' *Journal of International Oral Health*, 10(2) pp. 71-76.

Veldheer, S., Yingst, J., Foulds, G., Hrabovsky, S., Berg, A., Sciamanna, C. and Foulds, J. (2014) 'Once bitten, twice shy: Concern about gaining weight after smoking cessation and its association with seeking treatment.' *International Journal of Clinical Practice*, 68(3) pp. 388-395.

Velicer, W. F., Fava, J. L., Prochaska, J. O., Abrams, D. B., Emmons, K. M. and Pierce, J. P. (1995) 'Distribution of Smokers by Stage in Three Representative Samples.' *Preventive Medicine*, 24(4) pp. 401-411.

Vidrine, J. I., Businelle, M. S., Reitzel, L. R., Cao, Y., Cinciripini, P. M., Marcus, M. T., Li, Y. and Wetter, D. W. (2015) 'Coping Mediates the Association of Mindfulness with Psychological Stress, Affect, and Depression Among Smokers Preparing to Quit.' *Mindfulness*, 6(3) pp. 433-443.

Villeval, M., Gaborit, E., Berault, F., Lang, T. and Kelly-Irving, M. (2019) 'Do the key functions of an intervention designed from the same specifications vary according to context? Investigating the transferability of a public health intervention in France.' *Implementation Science*, 14(1) p. 35.

Vink, J. M., Willemsen, G., Beem, A. L. and Boomsma, D. I. (2005) 'The Fagerstrom Test for Nicotine Dependence in a Dutch sample of daily smokers and ex-smokers.' *Addictive Behaviors*, 30(3) pp. 575-579.

Visnovcova, Z., Mestanik, M., Gala, M., Mestanikova, A. and Tonhajzerova, I. (2016) 'The complexity of electrodermal activity is altered in mental cognitive stressors.' *Computers in Biology and Medicine*, 79 pp. 123-129.

Vuolo, M. and Staff, J. (2013) 'Parent and Child Cigarette Use: A Longitudinal, Multigenerational Study.' *Pediatrics*, 132(3) pp. 568-577.

Wald, N. J., Idle, M., Boreham, J. and Bailey, A. (1981) 'Carbon monoxide in breath in relation to smoking and carboxyhaemoglobin levels.' *Thorax*, 36(5) pp. 366-369.

Walsh, D. and Downe, S. (2006) 'Appraising the quality of qualitative research.' *Midwifery*, 22(2) pp. 108-119.

Wang, A.-L., Lowen, S. B., Romer, D., Giorno, M. and Langleben, D. D. (2015) 'Emotional reaction facilitates the brain and behavioral impact of graphic cigarette warning labels in smokers.' *Tobacco control*, 24(3) pp. 225-232.

Watts, A. and Addy, M. (2001) 'Tooth discolouration and staining: a review of the literature.' *British Dental Journal*, 190(6) pp. 309-316.

Weekley, C. K., Klesges, R. C. and Reylea, G. (1992) 'Smoking as a weight-control strategy and its relationship to smoking status.' *Addictive Behaviors*, 17(3) pp. 259-271.

Wegner, D. M. (1994) 'Ironic processes of mental control.' *Psychological Review*, 101(1) pp. 34-52.

Weinberger, A. H., Smith, P. H., Allen, S. S., Cosgrove, K. P., Saladin, M. E., Gray, K. M., Mazure, C. M., Wetherington, C. L. and McKee, S. A. (2015) 'Systematic and meta-analytic review of research examining the impact of menstrual cycle phase and ovarian hormones on smoking and cessation.' *Nicotine Tobacco Research*, 17(4) pp. 407-421.

Weiss, C., Hanebuth, D., Coda, P., Dratva, J., Heintz, M. and Stutz, E. Z. (2010) 'Aging Images as a Motivational Trigger for Smoking Cessation in Young Women.' *International Journal of Environmental Research and Public Health*, 7(9) pp. 3499-3512.

West, S. G., Stoney, C. M., Hughes, J. W., Matacin, M. and Emmons, K. M. (2001) 'Oral contraceptive use is associated with increased cardiovascular reactivity in nonsmokers.' *Annals of Behavioral Medicine*, 23(3) pp. 149-157.

Wetherill, R. R., Franklin, T. R. and Allen, S. S. (2016) 'Ovarian hormones, menstrual cycle phase, and smoking: a review with recommendations for future studies.' *Current Addiction Reports*, 3(1) pp. 1-8.

Whitehead, A. L., Sully, B. G. O. and Campbell, M. J. (2014) 'Pilot and feasibility studies: Is there a difference from each other and from a randomised controlled trial?' *Contemporary Clinical Trials*, 38(1) pp. 130-133.

Whittemore, R., Chase, S. K. and Mandle, C. L. (2001) 'Validity in Qualitative Research.' *Qualitative Health Research*, 11(4) pp. 522-537.

Wiggert, N., Wilhelm, F. H., Nakajima, M. and al'Absi, M. (2016) 'Chronic Smoking, Trait Anxiety, and the Physiological Response to Stress.' *Substance Use & Misuse*, 51(12) pp. 1619-1628.

Williams, A. L., Grogan, S., Clark-Carter, D. and Buckley, E. (2013) 'Appearance-based interventions to reduce ultraviolet exposure and/or increase sun protection intentions and behaviours: A systematic review and meta-analyses.' *British Journal of Health Psychology*, 18(1) pp. 182-217.

Willig, C. and Stainton-Rogers, W. (2017) *The SAGE Handbook of Qualitative Research in Psychology.* 2nd ed., Los Angeles: SAGE.

Willoughby, T., Good, M., Adachi, P. J., Hamza, C. and Tavernier, R. (2013) 'Examining the link between adolescent brain development and risk taking from a social-developmental perspective.' *Brain and cognition*, 83(3) pp. 315-323.

Wills, T. A., Sandy, J. M. and Yaeger, A. M. (2002) 'Stress and smoking in adolescence: a test of directional hypotheses.' *Health Psychology*, 21(2) pp. 122-130.

Witte, K. (1994) 'Fear control and danger control: A test of the extended parallel process model (EPPM).' *Communication Monographs*, 61(2) pp. 113-134.

Witte, K. (2008) 'Extended Parallel Process Model.' *In* Donsbach, W. (ed.) *The international encyclopedia of communication*. Hoboken (NJ): John Wiley & Sons Ltd. p. 1697–1700.

Witte, K. and Allen, M. (2000) 'A Meta-Analysis of Fear Appeals: Implications for Effective Public Health Campaigns.' *Health Education & Behavior*, 27(5) pp. 5591-5615.

Won, E. and Kim, Y.-K. (2016) 'Stress, the Autonomic Nervous System, and the Immune-kynurenine Pathway in the Etiology of Depression.' *Current Neuropharmacology*, 14(7) pp. 665-673.

World Health Organisation. (2017) *WHO report on the global tobacco epidemic 2017*. World Health Organisation. [Online] [Accessed 4th November 2017] https://apps.who.int/iris/bitstream/handle/10665/255874/9789241512824-eng.pdf

Yalcin, B. M., Unal, M., Pirdal, H. and Karahan, T. F. (2014) 'Effects of an Anger Management and Stress Control Program on Smoking Cessation: A Randomized Controlled Trial.' *The Journal of the American Board of Family Medicine*, 27(5) pp. 645-660.

Yehuda, R., Hoge, C. W., McFarlane, A. C., Vermetten, E., Lanius, R. A., Nievergelt, C. M., Hobfoll, S. E., Koenen, K. C., Neylan, T. C. and Hyman, S. E. (2015) 'Post-traumatic stress disorder.' *Nature Reviews Disease Primers*, 1, October, p. 15057.

Zhang, S., Paul, J., Nantha-Aree, M., Buckley, N., Shahzad, U., Cheng, J., DeBeer, J., Winemaker, M., Wismer, D., Punthakee, D., Avram, V. and Thabane, L. (2014) 'Empirical comparison of four baseline covariate adjustment methods in analysis of continuous outcomes in randomized controlled trials.' *Clinical Epidemiology*, 6 pp. 227-235.

Zigmond, A. S. and Snaith, R. P. (1983) 'The hospital anxiety and depression scale.' *Acta psychiatrica Scandinavica*, 67(6) pp. 361-370.

List of Appendices

Appendix 1 PRISMA Checklist.

Section/topic	#	Checklist item	Reported in section #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	(Section 3)
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	NA for thesis
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	Sections - 3.1.1 + 3.1.2
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	Chapter 4. Section 4.2.1
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	Section 3.2.1
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	Section 3.2.3
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	Section 3.2.1
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Section 3.2.2

Section/topic	#	Checklist item	Reported in section #
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	Section 3.2.4
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	NA
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	NA
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	NA
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	NA
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	NA
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	NA
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	Section 3.2.5
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	Section 3.3 +Figure 2 + Table 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Table 1
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome-level assessment (see Item 12).	NA

Section/topic	#	Checklist item	Reported in section #
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group and (b) effect estimates and confidence intervals, ideally with a forest plot.	For narrative summary Table 1
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	For narrative synthesis Section 3.3.1
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	NA
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	Quality assessment Table 2 + 3
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., health care providers, users, and policy makers).	Section 3.4.1
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review level (e.g., incomplete retrieval of identified research, reporting bias).	Section 3.4.3
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	Section 3.4.4
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	NA

Appendix 2 Interview schedule.

Thank you for agreeing to take part in this interview.

As we told you when you agreed to take part, we are exploring procedures for a study investigating whether showing women the effects of smoking on how their faces age can help them to stop smoking.

The age-progression morphing technique that you have seen has shown you how your face is likely to age if you give up smoking compared to how it will age if you continue to smoke.

We want to know about how you felt about the intervention, the questionnaire, and all the procedures. Any comments on how to make it more effective will be useful to us. **No names will be recorded so that any information you provide will be anonymous.**

<u>The Age-appearance Morphing Intervention</u>

1. So first of all, what did you think about the intervention?
2. How did you feel when you were doing it?
3. How did you feel immediately afterwards?
4. Did it affect your intention to smoke?
5. How could we make it more effective?
6. Were the instructions clear?

<u>The Questionnaire</u>

7. What did you think about the questionnaire?
8. Were there any parts of the questionnaire that made you uncomfortable? If so, what were they?
9. Were all sections clear? If not, which ones were not?
10. Are there any improvements you think we could make on this?

<u>Physiological Measurement</u>

11. How did you feel about the finger clips/electrodes?
12. Did you feel that having the electrodes on your fingers distracted you at all from focusing on the age-appearance images?
13. Is there anything we could have done to make this part of the study more comfortable for you?

14. Is there anything else that you would like to add?

Thank you for taking part…followed directly by **DEBRIEF**.

Appendix 3 Focus group script

Welcome

Welcome and thank you for coming to this focus group. Each of you has been selected to participate because your point of view is important to us. We know that you are very busy and we greatly appreciate your contribution to this project.

This interview is not a test, nor should it in any way be viewed as a series of questions with right or wrong answers. Remember, I am very interested in what you think and feel. We want to know your opinions on the intervention and procedures and we are certainly not interested in your agreeing with the opinions and feelings of others. There may be times, however, when you do, and it is appropriate for you to let us know that as well.

Purpose-

So, the purpose of this focus group is to explore procedures for a study investigating whether showing women the effects of smoking on how their faces age can help them to stop smoking.

The age-progression morphing technique that you have previously seen has shown you how your face is likely to age if you give up smoking compared to how it will age if you continue to smoke.

In this focus group, we want to discuss how you felt about the intervention, the questionnaire, and all the procedures.

Guidelines-

There are a few guidelines I would like to ask you to follow during the focus group discussion.

First, you do not need to speak in any particular order. When you have something to say, please do so.

Second, remember that it is important that we obtain the point of view of each one of you.

Third, you do not need to agree with what everyone or anyone in the group says, but you do need to state your point of view without making any negative comments or 'put downs.'

Fourth, because we have limited time together, I may need to stop you and to redirect our discussion.

So before we being does anyone have any questions?

Warm-up

I want you to write down a fake name on this post it note, ok so let us go round the room and say our fake name clearly into the Dictaphone.

Visualisation

I am now going to read out to you what I asked you to do during the intervention, I need you to visualise the time you came to take part. In front of you is a picture of the intervention.

- You were welcomed to the room, asked to fill in the consent from.
- Once completed I attached the electrodes to your finger and you completed the first questionnaire.
- The questionnaire-included questions regarding your smoking behaviour and attitudes, how much you think about the future, how you were feeling at the time and questions regarding your appearance.
- I then switched on the audio recorder and asked you to relax for 2 minutes
- Next, I showed you the intervention with a series of different morphing sequences.
- After the intervention, you were asked to read a leaflet, complete the second questionnaire including information about your smoking attitudes ad feelings.
- Lastly, you completed the breath test and participated in the interview.

Show picture of the intervention

Questions- put on cards and put to the back when asked and come back to at the end

Appendix 4 Participant intervention instructions.

Neutral Instructions	Reassuring Instructions
• I am now going to show you the intervention. (open laptop/tablet, open APRIL or webcam)	• I am now going to show you the intervention, it's quite simple and I will guide you through it. (open laptop/tablet, open APRIL or webcam)
• I am going to take a picture of your face, please position yourself in the centre of the screen and keep a neutral expression, (for participants with glasses ask to remove).	• I am going to take a picture of your face, please position yourself in the centre of the screen and keep a neutral expression, (for participants with glasses ask to remove).
• (load picture in APRIL and fill in set up information) what is your age and ethnicity?	• (load picture in APRIL and fill in set up information) what is your age and ethnicity?
• I am now going to edit your picture to match the stock image and match up the points of the face.	• I am now going to edit your picture to match the stock image and match up the points of the face.
• (once finished set up) On the screen you will see 2 pictures of your face, both pictures will age up to 72 each time, the one on the left will always be non-smoking and the one on the right will be with the effect of smoking.	• (once finished set up) On the screen you will see 2 pictures of your face, both pictures will age up to 72 each time, the one on the left will always be non-smoking and the one on the right will be with the effect of smoking
• **Morph2D-**please can you close your eyes and open them when I tell you to. You will see your face aged to 72.	• **Morph2D-** please can you close your eyes and open them when I tell you to open them, it can be a bit unexpected, do not be alarmed you will just see your face aged to 72. (smile empathically)
• Open your eyes; can you see any differences between the images?	• Open your eyes, can you see any differences between the images? It's normal to be surprised by the effects of time, especially if it's on our own picture (smile empathically)

• **Morph2D_R-** I am now going to show you the ageing process, when I press play you will see both images age to 72. (Press play) can you see any differences?	• **Morph2D_R-** I am now going to show you the ageing process, when I press play you will see both images age to 72, again do not be alarmed as it is just the morphing process. (Press play) can you see any differences? ____(smile empathically)
• **Morph2D_R'-** I am going to repeat the ageing process again now (press play) Can you see any other differences?	• **Morph2D_R'-** I am going to repeat the ageing process again now, it is exactly the same to what you just saw, so no new surprises (press play) Can you see any other differences?
• **Morph3D-** I am now going to change the pictures to a 3D image of your face, I am going to show you again the ageing process and after you can move your own face around to view the sides and underneath. (give demonstration),	• **Morph3D-** I am now going to change the pictures to a 3D image of your face, I am going to show you again the ageing process and after you can move your own face around to view the sides and underneath (give demonstration), don't worry it is not that much different from the previous images.
• (Press play) can you see any differences?	(Press play) can you see any differences?
• You can now use the mouse or keypad to move your face around (give demonstration).	• You can now use the mouse or keypad to move your face around if you want to.
• **Morph3D_R-** I am going to repeat the ageing again in the 3D view (press play) • Can you see any more differences? Would you like to move your face around again?	• **Morph3D_R-** I am going to repeat the ageing again in the 3D view (press play) • Can you see any more differences? Would you like to move your face around again? It's ok if you have nothing to add.
• **Participant Lead intervention time (Freetime)** you can now have a look at the intervention on your own, you can drag the progress bar to different age levels. Notify me when you have finished	• **Participant lead intervention time (Freetime)** I you want to you can now have a look at the intervention on your own, you can drag the progress bar to different age levels. Please let me when you have finished

Appendix 5 Non Maximum likelihood (ML) imputed ANCOVA analysis

Primary and secondary continuous smoking outcomes, non maximum likelihood imputed ANCOVA result.

Measure	*n*	*F*	*p*	ηp^2
Intentions				
1-month	60	.88	.419	.03
3-months	53	3.75	.030	.13
Attitudes				
1-month	60	.01	.994	.00
3-months	53	.71	.497	.03
PBC				
1-month	60	.30	.739	.01
3-months	53	1.18	.317	.05
SN				
1-month	61	2.59	.084	.09
3-months	53	1.39	.260	.05
Sum of cigarettes				
1-month	60	.81	.452	.03
3-months	72	.30	.741	.01

Note: df = 2, PBC = perceived behavioural control, SN = subjective norm, post hoc analysis of intentions post-intervention indicate Reassuring arm had higher scores in intention to quit than the Control arm Mean difference=1.52, p = .026. ηp^2 *= partial eta squared.*

Appendix 6 Cronbach alpha scores Pilot

Cronbach's alpha values of all data collection time points, within the pilot

Measure	pre-	post-	1-	3-	6-
Intentions	.78	.90	.92	.97	.96
Attitudes	.66	.83	.91	.83	.79
PBC	.82	.92	.89	.88	.88
SN	.27	.87	.56	.97	.99

Note: PBC= perceived behavioural Control, SN=Subjective norms.

Appendix 7 CONSORT checklist.

CONSORT 2010 checklist of information to include when reporting a randomised trial*

Section/Topic	Item No	Checklist item	Reported in section
Title and abstract			
	1a	Identification as a randomised trial in the title	Chapter 9
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	1.2.8
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale	Sections 9.2 + 9.2.1
	2b	Specific objectives or hypotheses	Section 9.2.2
Methods			
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	Sections 5.3.2 + 9.3.1 + 9.3.3
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	NA
Participants	4a	Eligibility criteria for participants	Section 5.6.1
	4b	Settings and locations where the data were collected	Section 5.7.2
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	Section 5.5.1
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	Sections 9.3.2. + 5.5.4
	6b	Any changes to trial outcomes after the trial commenced, with reasons	NA
Sample size	7a	How sample size was determined	Section 5.6.3.2.5
	7b	When applicable, explanation of any interim analyses and stopping guidelines	NA

Randomisation:			
Sequence generation	8a	Method used to generate the random allocation sequence	Section 5.6.3.2
	8b	Type of randomisation; details of any restriction (such as blocking and block size)	Section 5.6.3.2
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	Sections 5.6.3.2
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	Sections 5.6.3.2
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how	Section 5.6.3.2.4
	11b	If relevant, description of the similarity of interventions	Section 5.5.1
Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	Section 5.8.2.2.2
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	Section 5.8.2.2.4
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	Section 9.3.3 Figure 18
	13b	For each group, losses and exclusions after randomisation, together with reasons	Section 9.4.2
Recruitment	14a	Dates defining the periods of recruitment and follow-up	Section 5.6.3.2.6
	14b	Why the trial ended or was stopped	NA
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	Table 29 9.3.3
Numbers analysed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	Figure 18 9.3.3
Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	Sections 9.4.5 + 9.4.6

	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	NA
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	Sections 9.4.6.1 + 9.4.6.2 + 9.4.8
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	NA
Discussion			
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	Sections 9.5.4
Generalisability	21	Generalisability (external validity, applicability) of the trial findings	Section 9.5.2
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	Section 9.5.2
Other information			Section 9.3
Registration	23	Registration number and name of trial registry	
Protocol	24	Where the full trial protocol can be accessed, if available	NA
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	NA

*We strongly recommend reading this statement in conjunction with the CONSORT 2010 Explanation and Elaboration for important clarifications on all the items. If relevant, we also recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological treatments, herbal interventions, and pragmatic trials. Additional extensions are forthcoming: for those and for up to date references relevant to this checklist, see www.consort-statement.org.

Appendix 8 Cronbach alpha scores RCT

Cronbach's alpha values of data collection time points, within the RCT.

Measure	pre-	post-	1-	3-	6-
Intention	.86	.84	.75	.83	.90
Attitudes	.74	.81	.90	.81	.80
PBC	.83	.86	.88	.89	.84
SN	.66	.61	.46	.69	.77
HAD D	.29	-	.38	.66	.63
HAD A	.70	-	.74	.72	.73
PSS	.32	-	.36	.25	.64
Appearance orientation	.76	-	-	-	-
Appearance evaluation	.87	-	-	-	-
WCS	-	-	-	-	.87

Note: HADS A/D = Hospital Anxiety and Depression scale, PBC = perceived behavioural control, PSS = Perceived Stress Scale, SN = Subjective norms, WCS = Weight Concern Scale.[-] = not measured at that time point.

Appendix 9 Non-parametric testing (Kruskal-Wallis) of percentage change of smoking outcomes.

Added analysis of percentage of primary variables is provided below. As there is no non-parametric equivalent of ANCOVA, standardized versions of outcomes (% change from baseline) were implemented. Similar results as ANCOVA analysis were obtained, with the exception of pairwise comparisons of intentions at 6-months post-intervention, which indicates that the Reassuring arm had significantly higher intentions at this time compared to the Control arm.

Non-parametric Kruskal-Wallis percentage change of primary and secondary continuous smoking outcomes, results across follow up time points.

Outcome	*n*	X^2	*p*
Intentions % change			
post-	72	1.77	.413
1-month	60	1.83	.402
1-month ML	72	1.75	.416
3-months	53	8.39	.015
3-months ML	72	12.22	.002
6-months	40	6.59	.037
Attitudes % change			
post-	72	.25	.881
1-month	60	.68	712
1-month ML	72	.56	.756
3-months	53	1.35	.510
3-months ML	72	3.66	.160
6-months post	40	1.21	.546
SN % change			
post-	72	1.63	.443
1-month	60	2.78	.249
1-month ML	72	2.95	.229
3-months	53	3.46	.178
3-months ML	72	6.42	.040*
6-months	40	1.92	.383
Sum of cigarettes % change			
1-month	60	.89	.641
1-month ML	72	1.08	.584
3-months	53	2.32	.313
3-months ML	72	2.14	.343
6-months	40	4.16	.125

Note: ML= Maximum likelihood imputed variables, SN=subjective norms, df = 2.
Post hoc analysis: i) Intention percentage change at 3-months post-intervention, Reassuring condition 15% higher than Control p =.016. ii) ML intentions percentage change at 3-months post-intervention, Reassuring 21 % higher than Controls, p = .003, Reassuring 16 % higher than Neutral arm, p =.018. iii) Intentions percentage change at 6-months post-intervention, Reassuring 11% higher than Control, p = .04.

Appendix 10 Exploration of the impact of COVID-19 on 6-months post-intervention

Thirty percent of participants were expected to fill in the 6-months post-intervention questionnaires during the COVID-19 lockdown (23.03.20). Out of those participants, 29% failed to complete the questionnaire. At 6 months post-intervention, n = 5/40 participants responded that they were abstinent, n = 3 (60%) of those abstinent responded pre-lockdown and n = 2 (40%) post lockdown. A Chi square test indicated no significant difference in the proportion of participants that responded stating 7 day point abstinence at 6-months post-intervention before-, or during-lockdown X^2 (1) = .83, p = .361. See the Table below for the spread of 6 months post-intervention abstinence across lockdown

7 day point abstinence at 6-months post-intervention, within or not within Covid-19 lockdown, across intervention arms.

Participant completion	7 day point abstinence			
	Control (n/%)	Neutral (n/%)	Reassuring (n/%)	Total (n/%)
Before-lockdown	0 (0)	1 (33)	2 (67)	3 (100)
During-lockdown	0 (0)	0 (0)	2 (100)	2 (100)
Total	0 (0)	1 (20)	4 (80)	5 (100)

Note: Lockdown refers to the government stay at home order due to COVID-19

Appendix 11 Correlation matrix of measurements of stress and quit smoking intentions at 3-months post-intervention.

Correlation matrix of measurements of stress and quit smoking intentions at 3-months post-intervention.

Variable	N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Sub Stress pre-Intervention	72	-																				
2. Sub stress immediately post	72	.35**	-																			
3. Sub stress post-intervention	72	.48**	.71**	-																		
4. Baseline EDA Tonic	70	.15	.32**	.23	-																	
5. Morph2D EDA Tonic	70	.16	.30*	.23	.97**	-																
6. Morph2D_R EDA Tonic	70	.16	.30*	.22	.97**	.99**	-															
7. Morph2D_R' EDA Tonic	70	.16	.28*	.21	.98**	.99**	.99**	-														
8. Morph3D EDA Tonic	70	.16	.30*	.23	.98**	.99**	.99**	.99**	-													

Variable	*N*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
9. Morph3D_R EDA Tonic	70	.18	.30*	.24*	.98**	.99**	.99**	.99**	.99**	-												
10. Baseline EDA Amp	67	.19	.29*	.25*	.99**	.97**	.97**	.97**	.97**	.97**	-											
11. Morph2D EDA Amp	69	.19	.27*	.24*	.97**	.99**	.99**	.99**	.99**	.98**	.97**	-										
12. Morph2D_R EDA Amp	68	.16	.27*	.18	.97**	.99**	.99*	.99**	.99**	.98**	.97**	.99**	-									
13. Morph2D_R' EDA Amp	68	.18	.26*	.18	.97**	.99**	.99**	.99**	.99**	.99**	.97**	.99**	.99**	-								
14. Morph3D EDA Amp	70	.17	.29*	.22	.97**	.99**	.99**	.99**	.99**	.99*	.97**	.99**	.99**	.99**	-							
15. Morph3D_R EDA Amp	68	.20	.24*	.19	.97**	.98**	.98**	.98**	.99**	.99**	.96**	.98**	.98**	.98**	.99**	-						
16. Baseline HR	72	-.16	-.16	-.18	.10	.08	.09	.09	.09	.10	.06	.07	.07	.05	.08	.07	-					
17. Morph2D HR	72	-.091	-.09	-.15	.10	.08	.09	.09	.09	.08	.07	.08	.06	.04	.07	.06	.86**	-				

Variable	*N*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
18. Morph2D_R HR	72	-.08	-.10	-.10	.10	.09	.10	.10	.10	.11	.07	.08	.07	.06	.08	.08	.92**	.85**	-			
19. Morph2D_R' HR	72	-.11	-.10	-.20	.10	.10	.11	.11	.10	.11	.08	.10	.09	.07	.09	.08	.88**	.92**	.91**	-		
20. Morph3D HR	72	-.13	-.07	-.18	.09	.08	.09	.09	.09	.10	.06	.07	.07	.06	.07	.07	.93**	.82**	.95**	.88**	-	
21. Morph3D_R HR	72	-.14	-.11	-.19	.12	.09	.11	.11	.11	.12	.08	.09	.08	.07	.09	.08	.94**	.88**	.91**	.91**	.96**	-
22. Intentions 3-months post-intervention	72	.02	.03	.01	.05	.08	.06	.06	.06	.06	.08	.11	.08	.08	.06	.08	-.01	.11	.01	.07	-.05	-.04

Note: Sub stress = Subjective stress, EDA Tonic = Tonic levels of electrodermal activity, EDA Amp = mean amplitude of electrodermal activity, HR = Heart Rate.
**, p<.05, **, p <.001.*

Appendix 12 Influence of age and menstrual phase on measures of physiological stress

Summary table of repeated measures ANOVA of the between subjects effect of age on physiological stress percentage change measures

	Simple main effect of Morph phase within group				Between subjects effect				Interaction time*intervention			
	F	*df*	*p*	ηp^2	*F*	*df*	*p*	ηp^2	*F*	*df*	*p*	ηp^2
EDA Tonic (µS)	18.10	2.591, 176.173	.001	.21	7.10	1,68	.010	.10	4.87	2.591, 176.173	.004	.07
EDA AMP (µS)	14.86	2.106, 132,685	.001	.19	7.78	1,63	.007	.11	5.26	2.106, 132,685	.006	.08
HR (BPM)	2.69	3.295, 230.626	.042	.04	.00	1,70	.992	.00	.20	3.295, 230.626	.911	.00

Note: EDA Tonic = electrodermal activity tonic measurement, EDA Amp = electrodermal activity mean amplitude measurement. HR = Heart rate as measured by BPM. df = degrees of freedom, ηp^2= partial eta squared. µS = microsiemens, BPM = Beats Per Minute, ηp^2 = partial eta squared.

EDA Tonic percentage change revealed a significant between subjects' effect of age. Post hoc tests revealed that participants aged over 35 (n = 6) had significantly higher levels of EDA Tonic percentage change across morphing phases than the those aged under 35 n = 64, with a mean difference of 21%, p = .010.

EDA Amp percentage change revealed a significant between subjects' effect of age. Post hoc tests revealed that participants aged over 35 (n = 4) had significantly higher levels of EDA Amp percentage change across morphing phases, than the those aged under 35 n = 61, with a mean difference of 24%, p = .007.

Summary table of repeated measures ANOVA of the between subjects effect of Menstrual phase on physiological measures of stress.

	Simple main effect of Morph phase within group				Between subjects effect				Interaction time*intervention			
	F	*df*	*p*	ηp^2	*F*	*df*	*p*	ηp^2	*F*	*df*	*p*	ηp^2
EDA Tonic (µS)	16.43	2.602, 174.321	.001*	.20	1.68	2,67	.194	.05	5.20	2.602, 174.321	.185	.04
EDA AMP (µS)	14.12	1.996, 123.768	.001*	.19	1.04	2,62	.359	.03	1.14	3.993, 123.768	.340	.04
HR (BPM)	8.08	3.233, 223,098	.001*	.11	1.91	1,69	.156	.05	.74	6.467, 223.098	.684	.02

Note: EDA Tonic = electrodermal activity tonic measurement, EDA Amp = electrodermal activity mean amplitude measurement. HR = Heart Rate as measured by BPM. df = degrees of freedom, ηp^2= partial eta squared. µS = microsiemens, BPM = Beats Per Minute, ηp^2 = partial eta squared.

Appendix 13 Appearance and depression relationship.

Significant medium negative relationships were observed between Appearance evaluation measured pre-intervention and levels of depression measured at pre- (N = 72, r = -.44, p<.001), 3-months (n = 53, r =-.47, p <.001) and 6-months (n = 40, r =-.34, p =.032) post-intervention. Comparisons at 6-month post-intervention did not remain significant at the corrected alpha level of p = .01.

The negative relationships indicate that lower scores of Appearance evaluation (indicating negative body image perceptions) were related to increased scores of depression, across the majority of follow up time points of the RCT.