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What's so special about Proust Phenomenon? A mixed-method investigation of autobiographical memory cued by odour and image

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ABSTRACT

This study compared memories evoked by olfactory and visual stimuli. It was hypothesised that autobiographical memory cued by odour would be experienced differently to those cued by image. Such findings would provide support for the idiosyncratic nature of Proust Phenomenon, and furthermore how autobiographical-memory may operate within separate-memory-functions. The experiment utilised a mixed-methods design using a combination of quantitative and qualitative research methods. This enabled statistical analysis of memory characteristics whilst also enabling exploration of rich memory descriptions. 26 participants took part in a between-subjects design with two conditions. Participants were exposed to either twelve odours or twelve images and asked to describe and rate memories using Likert scales. The results demonstrated no significant difference in the emotion, evocativeness, vividness, age or frequency across odour and image cued memories. However thematic analysis yielded three main themes unique to olfactory memory; rich place detail, bonded relationships and strong emotion. This suggests that memories evoked by odour have distinctive qualities supporting the notion of Proust Phenomenon.

KEYWORDS:	AUTOBIOGRAPHICAL	MEMORY	ODOUR	PROUST PHENOMENON	SMELL

Introduction

Proust phenomenon is a well-known folk belief (Schab, Odor Memory: Taking Stock, 1991), a memory curiosity which is named after Marcel Proust, who described a vivid memory from his childhood evoked by the smells and taste of a tea-soaked Madeleine biscuit (Proust, 1928). Many people report that odours can spontaneously evoke memories which are experienced as different, more vivid, more emotional, older and give a sensation of being taken back in time. These memories are involuntary and occur rapidly when exposed to unexpected, but familiar, odours (Chu & Downes, 2002). Despite this common folk-belief, scientific research has been unable to reach a consensus concerning any unique existence or functionality of a smell memory. This lack of consensus is often attributable to the problematic nature of Proust Phenomenon in respect to any scientific investigation. Experimentally, a number of methodological issues arise due to the idiosyncratic nature of odours and subsequent difficulties in odour identification. Secondly, the spontaneous nature of Proust Phenomenon ensures that any experimental findings require caution, confounded by the necessity within memory studies to rely on self-report data. In 1984, Rubin, Groth and Goldsmith published the first direct experimental attempt at inducing Proust Phenomenon, measuring the attributes recognised within a folk-belief model of the experience. However, the results only demonstrated a difference in time since last thought about, when compared to word and image stimuli. Subsequent research has used a variety of methodological techniques to expand on the measurements set by this study; repeated-measures design, double-cue stimulus administration and naturalistic environments. This research intends to experimentally investigate the properties of autobiographical memories cued by odours and images by using a mixed-method design to provide evidence for any unique properties of Proust Phenomenon. The following will begin by discussing two key psychological contributors to the consideration of Proust Phenomenon, memory, and the biological olfactory process, followed by a review of literature which has directly sought to investigate this experience.

Memory

A Multiple Memory Systems model provides the conceptual framework for how the individual senses encode memory by utilising multiple modalities. This views olfactory memory as a discrete memory system, potentially with separate sub-divisions (Herz & Engen, 1996); (Schab, Odor Memory: Taking Stock, 1991); (Chu & Downes, 2002). This model is evidenced by repeated-test experiments demonstrating slower decline of olfactory memory compared to other sensory stimuli, and functional dissociation shown in Korsakoff participants who maintain odour memory despite losing memory function from their other senses (Herz & Engen, 1996; Engen & Ross, 1973).

The forms of memory expressed in Proust Phenomenon are episodic-autobiographical in nature, thus they detail personal occurrences, spatially-placed alongside other experiences, which include general, specific, and lifetime-period details. They are in essence a form of Mental Time Travel (Tulving, 1972); (Rubin, Groth, & Goldsmith, 1984) (Conway & Pleydell-Pearce, 2000). These autobiographical memories are also involuntary and spontaneous; the memory is not consciously recalled but instead cued by a stimulus, in this case an odour, in the environment. As such, they are frequently experienced as a novelty by the

participant. However, research has demonstrated that involuntary memories are instead part of a basic model of association across the senses, providing a functional reminder that we are more than just the present. This enables our past to influence daily behaviour without a need for conscious recollection, as demonstrated by research showing that we have at least three to twenty involuntary memories per day, across all senses and thought processes, without any conscious intention (Bernsten, 1996); (Berntsen, 2009). These memories are shown to be mainly positive and have psychological protective features. They can be, however, also observed as a maladaptive behaviour within conditions like post-traumatic-stress disorder (PTSD) and obsessive compulsive disorder (OCD) (Berntsen, 2009; Mace, 2004). This leads to a consideration of whether Proust Phenomenon experienced memories are a unique curiosity. Indeed Mace (2004) demonstrated that only 3% of involuntary memories were cued by smell or taste. This suggests that the popularity of Proustian type experiences may be due to how odour memory is perceived rather than an actual measured difference.

The Biological Olfactory System

The oflactory system has three major uses; ingestion, avoiding environmental hazards through iliciting fear and disgust, and social communication (Stevenson, 2010). The following will describe the main olfactory cranial nerve system (CN1) which facilitates taste, detection of spoiled or noxious substances, and odour perception. As odour molecules travel up the nostril, they are caught by mucus which transports them to olfactory receptors which extend out on hair-like structures, the olfactory cilia, from an area of tissue called the olfactory epithelium. This area contains many thousands of receptors, more than any other sensory system except vision, which are topographically organized and located into zones on the cilia surface. A stimulus odour is broken into molecules, each of which activates a single corresponding receptor; this action encodes a complex pattern of excitation and inhibitory responses which lead to the odour being encoded as a whole. Therefore, the molecular configuration, dependant on the individual exposure, is influential in the persons' interpretation of the odour. On receiving this pattern, the olfactory bulb releases neurotransmitters understood by the various brain areas, in particular the amygdala, which processes emotional reactions and the hippocampus, significant for autobiographical memory (Doty, 2001).

Olfactory function is influenced by a number of factors. Anosmia is odour blindness, due to olfactory nerve damage or genetic differences which result in missing or malfunctioning odour receptors, reducing the possibility that the pattern mentioned earlier is identifiable (Coren, Ward, & Enns, 2004). Gender, age and cultural differences are also shown to affect a person's experience of odours. Women, for example, demonstrate a superior sense of smell which is cross-cultural, noticeable from early childhood and declines more slowly in older age (Doty R. L., 2001). Furthermore, cross-cultural variation in oflaction attitudes has also been demonstrated. Mexican participants are shown to be most likely to use odour-stimulated emotions and memories in daily decision processes. In contrast, European participants value odours more for environmental aesthetics. These differences are suggested to arise from personal space norms and lifestyle attitudes, and are defined by odour exposure early in life (Seo, et al., 2011).

Proust Phenomenon Literature Overview

In 1935 Laird published a paper which investigated Proust Phenomenon using anecdotal accounts of memory, determining that odour-induced autobiographical-memory is individual. For some it was considered frequent, for others novel. It was experienced more frequently by women, and resulted in more emotionally vivid-memories which had mood changing capacity. Even at this early date, Laird offered that a lack of research into olfactory phenomena had resulted in missed educational or advertising opportunities.

In an attempt to investigate the phenomenon more robustly Rubin, Groth and Goldsmith (1984) asked participants to write down memories cued by exposure to odour, image and word stimuli, and then used Likert scales to measure the attributes considered to be special to Proust Phenomenon: emotion, vividness, evocativeness, age and frequency of last thought about. The following will consider the findings of this study along with subsequent attempts at investigating the phenomenon within each measured attribute.

Emotion

Rubin, Groth, & Goldsmith's (1984) original study did not demonstrate any support for odour memories being more emotional. However, people frequently report olfactory sensory experiences as more emotionally loaded than memories cued by other senses, a perspective supported by a folk understanding of Proust Phenomenon and subsequent research (Chu & Downes, 2000) (Herz & Engen, 1996) (Larsson & Willander, 2009). In a later study, Herz (1998) exposed participants to olfactory, auditory and visual stimuli whilst viewing a piece of artwork. In a follow up study, the participants who had been exposed to odours were shown to remember the artwork as more emotionally potent with no other unique attributes (Herz R. S., 1998). These findings are supported by Herz and Schooler (2002) in a study specifically using odours identified as relating to childhood, for example Play-Doh. Using a double-cue method to calculate the attributes of memory irrespective of name availability, the participant was provided with a verbal label for each cue and then asked to describe a relevant autobiographical memory and measures were taken using Likert scales. The participants were then presented with each cue in both visual and olfactory form, followed by repeated measures rating scales. The results demonstrated that memories cued by odour were rated as more emotional with no other unique attributes. As a final supportive study, Herz (2004) carried out a naturalistic experiment using olfactory, visual and auditory stimulus to represent popcorn, fresh-cut-grass and camp-fire. Participants were asked to think of autobiographical memories to represent each object, following which, the participant was then exposed to each stimulus and asked to respond to a number of questions using Likert response scales. Olfactory memories were shown as more emotional and evocative than memories presented in auditory, visual or verbal form. Since this particular aspect is well supported, it is suggested that direct processing paths to the amygdala may ensure that olfactory experiences are more strongly attached to events, which on recollection later leads to a stronger emotional response (Chu & Downes, 2000) (Herz & Engen, 1996) (Larsson & Willander, 2009). However, some research has suggested that only basic emotions are linked to olfactory function, demonstrating that people have difficulty in naming odours associated with anger, sadness, and surprise, but not happiness or disgust (Croy, Olgun, & Joraschky,

2011). In a further study, when participants watched an aversive film whilst exposed to olfactory, auditory, and visual ambient stimuli the results demonstrated that memories evoked by odours are more detailed, arousing, and unpleasant than memories evoked by auditory stimuli. However, odours and images demonstrated no difference (Toffolo, Smeets, & Van den Hout, 2012).

Vividness

Despite folk belief, no evidence since Laird's original study (1935) has demonstrated odour cued autobiographical memories being reported as more vivid than those cued by other senses (Rubin, Groth, & Goldsmith, 1984); (Herz & Schooler, 2002); (Herz R. , 2004). Evidence has been shown, however, for the proficiency of ambient odours to enhance the retention of experience details as per Toffolo, Smeets, & Van den Hout's (2012) previously described aversive film study. In addition, Aggleton and Waskett (1999) exposed visitors to the Jorvik Viking Centre Museum to appropriate Viking ambient-odours in the presence of educational material. On testing, odour cues were shown as the most effective reminders of contextual information. Furthermore, Chu and Downes (2002) used double-cue methods, when participants' first retrieve a memory to a verbal word followed by exposure to a matching odour, and demonstrated a differential encoding bias hypothesis. The results suggested that olfactory details are peripheral in nature and not required for the meaning or interpretation of events. Thus, if autobiographical memory is cued by odour, then the memory must have been more deeply encoded in the first place, which could lead to the sensation of odour as cues to more vivid memories (Aggleton & Waskett, 1999).

Age and frequency of thought about

Proust Phenomenon anecdotal accounts frequently report that odours facilitate access older and previously un-thought-about memories, suggesting that odour encoded memories are more resistant to decay than those encoded due to other stimuli (Schab, Odor Memory: Taking Stock, 1991) (Herz & Engen, 1996). Rubin, Groth and Goldsmith (1984) did not show any difference within the age of word, image, or odour evoked memories. A difference in frequency of thought about was shown however, these results have not been consistently supported within the scientific literature. Further studies have mapped odour evoked memories onto the known distribution of autobiographical memories, composed in adults of three components; childhood amnesia, that is the lack of memories available for early childhood, followed by an abundance of memories between the ages of 10-30, and finally the improved retention of memories from the last ten years, named the recency period (Larsson & Willander, 2009).

Using older participants Chu and Downes (2000) showed that odour-cued memories are older and demonstrate a younger memory bump peaking at 6-10 years. In addition, Willander and Larsson (2007) presented older-aged participants with words, odours, or odours and words and demonstrated that odour-only-stimuli are more likely to stimulate memories from the first two decades of life. These studies would suggest that inconsistencies within research could be a result of using a young participant groups.

Evocativeness

A striking attribute of anecdotal Proust Phenomenon accounts is that of evocativeness, the sensation of being taken back to a memory's original time or place. It is suggested that direct pathways from the olfactory bulb to the hippocampus and prefrontal cortex may facilitate an autonoetic sensation which generates the evocativeness of odour induced memories. There has been mixed support for odour cued memories being more evocative. However, Herz & Schooler (2002) and Herz (2004) did indeed demonstrate that memories evoked by odour gave more of a sensation of being 'brought back'. Support for evocativeness is also provided by research into Mental Time Travel (MTT) which considers a person's ability to imagine themselves in the past and future. Miles and Bernsten (2011) demonstrated that odour cues were better at facilitating remote past events but not future, in contrast to verbal and image cues, potentially due to enhanced proactive interference and reduced retroactive interference. Put simply, memories encoded on first exposure to an odour remain strong and inhibit the encoding of experience on subsequent exposures.

Justification of Method

This research study is shaped by the limitations and opportunities for future research as highlighted within previous research. For example, studies are needed which focus on the structural formation of autobiographical memories across modalities, considering qualitative qualities such as pleasantness, complexity, intensity and familiarity to distinguish the special or unique attributions of odour stimulated autobiographical memory (Herz & Cupchik, 1992) (Herz & Engen, 1996) (Chu & Downes, 2002) (Schlagman, Schulz, & Kvavilashvili, 2006).

To address this, gap, an integrated mixed-methods design will be used to investigate the characteristics of spontaneously experienced autobiographical memories as evoked by odour or image. The quantitative aspect enables deductive enquiry, using statistical analysis to test hypotheses and make predictions which can be generalized across the human population. In contrast qualitative analysis enables inductive reasoning allowing the exploration of autobiographical memory (Bryman, 2006). An important perspective of mixed-methods is that the process does not guarantee a whole truth, but is however utilised to inform judgements (Hammersley, 2005). This technique allows a process termed triangulation, offering a combination of ways to use the data; elaborating, providing support or contradicting, thus leading to an interrogation of the methods with an end point of generating leads for future research. This approach is considered particularly suitable when, as with Proust Phenomenon, previous research findings are inconsistent (Bryman, 2001; Bryman, 2006; Tashakkori & Teddlie, 2008; (Dahlberg, Wittink, & Gallo, 2010).

Hypothesis and Research Question

A mixed-method approach will seek to provide evidence for Proust Phenomenon, by investigating the characteristics of autobiographical-memories which have been cued by odour or image. It is hypothesised that, in-line with previous literature and folk-belief, odour-cued memories will be experienced as emotionally different, more

evocative, vivid, older and thought about less often in contrast to those memories cued by image. In addition, thematic analysis will be used to consider the transcribed memory descriptions, as cued by odour or image, allowing an exploration of any identified differences.

Prior to the main study, details of a norming study will be provided. This study was executed to compare the identfiability of the stimuli, with and without verbal labels, and thus assess the suitability for use within the experiement. It is hypothesised that, in-line with current literature, odours will be correctly identified less readily than images.

Norming Study

Introduction

Human smell is often considered an inferior sense, with preference shown for using visual, auditory and tactile senses when identifying objects and spaces (Coren, Ward, & Enns, 2004). Humans are, however, sensitive in the detection and discrimination of odours, and support for the role of smell in human behaviour is evident. Children, for example, are shown to attach high importance the smell of relatives and familiar places like their parents' car (Ferdenzi, Coureaud, Camos, & Schaal, 2008) and breastfeeding infants are also shown to orient themselves to the auxiliary odour of their mothers when exposed to the auxiliary odour of another female (Cernoch & Porter, 1985).

However, our ability to identify familiar odours is impaired in comparison to other senses, and shown to rarely exceed 50% (Cain, 1979). This limitation may reflect a lack of evolutionary need to identify odours; it is, for example, more important to detect spoilt food or smoke than it is to abstractly label the source (Doty R. L., 2001). There are a number of contributors to this issue; firstly, the molecular basis by which odours are encoded and fewer connections with the association structures (Doty, 2001), secondly, that language lacks abstract descriptive words for odours (Herz & Cupchik, 1992), and thirdly, a lack of availability of odour imagery (Schab, 1991). This final limitation is also complicated by the tendency to label odours by the objects which are characterised by the smell. Methyl-salicylate (wintergreen or mint), for example, has a distinctive odour recognisable only by its use in products like mouthwash, disinfectant, and toothpaste. On smelling an odour, and following the biological process described earlier, people are thought to take a 'most likely' approach to identification (Schab, 1991; Engen, 1982).

The resulting implication is that stimuli used to investigate visual and olfactory behaviour may not be directly comparable. If a memory cued by stimuli with an available verbal label is compared to one without, then experimentally, it cannot be determined that the difference is not due to the label. Several studies have used double-cue techniques to negotiate this issue, however, in the current study it was decided not to give access to an odour label since research has also demonstrated that odour attributes of pleasantness, intensity, and familiarity are influenced by perceived positive and negative labels attached to the odour. Equally the availability

of semantic information for an odour has been shown to change the process from a perceptual to a conceptual process. (Herz, 2000; Herz, 2003; (Herz & von Clef, 2001).

Alternatively, a norming study was conducted with a different group of participants to assess, and compare the identifiability of the selected odours and images and maximise experimental rigour.

Method

Study design

A between-subjects design was used with two conditions, odour and image, each with 12 participants.

Participants

Twenty-four participants were recruited opportunistically from mixed convenient settings. A participant information sheet and debrief was administered and informed consent gained. No further demographic data was collected.

Materials

Stimuli were prepared and administered in a manner identical to the main study. See *Materials-Stimuli* section for details.

Procedure

The experiment was scheduled after the main study to minimise any demand characteristics, due to participants discussing the stimuli. Following a three second exposure to each stimulus each participant was asked two questions: (a) what is this?, (b) is this [insertion of semantic label]? Responses were then recorded on a simple tally sheet.

Analysis

Across both stimuli, responses were scored using the researcher's own judgement and allowing for synonyms or labelling considered acceptable for example 'gingerbread' and 'cinnamon' or 'smoke' instead of 'bonfire' Incorrect names were those considered wrong, for example 'grease' instead of 'damp forest' or those too broad for example 'perfume' instead of 'talcum powder'.

Results

The results demonstrated that when identifying odour or image without a verbal label, there is a significant difference in performance. 28% of odours were correctly identified in contrast to 84% of images. A Chi-square test for independence (with Yates Continuity Correction) indicated a significant association between stimulus type (odour or image) and ability to correctly identify without a verbal label χ^2 (1, n = 288) = 92.4, $p < .001$, *phi* = -.57.

A McNemar test demonstrated a significant increase in the correct identification of a stimulus following the presentation of a verbal label, $\chi^2(1, n = 288) = p < .001$. However, performance remained significantly different across the conditions with 71% of odours correctly identified on presentation whilst 100% of images were correctly identified. A Chi-square test for independence (with Yates Continuity Correction) indicated a significant association between stimulus type (odour or image) and ability to correctly identify without a verbal label $\chi^2(1, n = 288) = 49.2$, $p < .001$, $phi = -.42$. The image of Ginger ale (0%) was identified as a poor representation with participants answering lager or pint. The full response-range to stimuli is illustrated in Figure's 1 and 2.

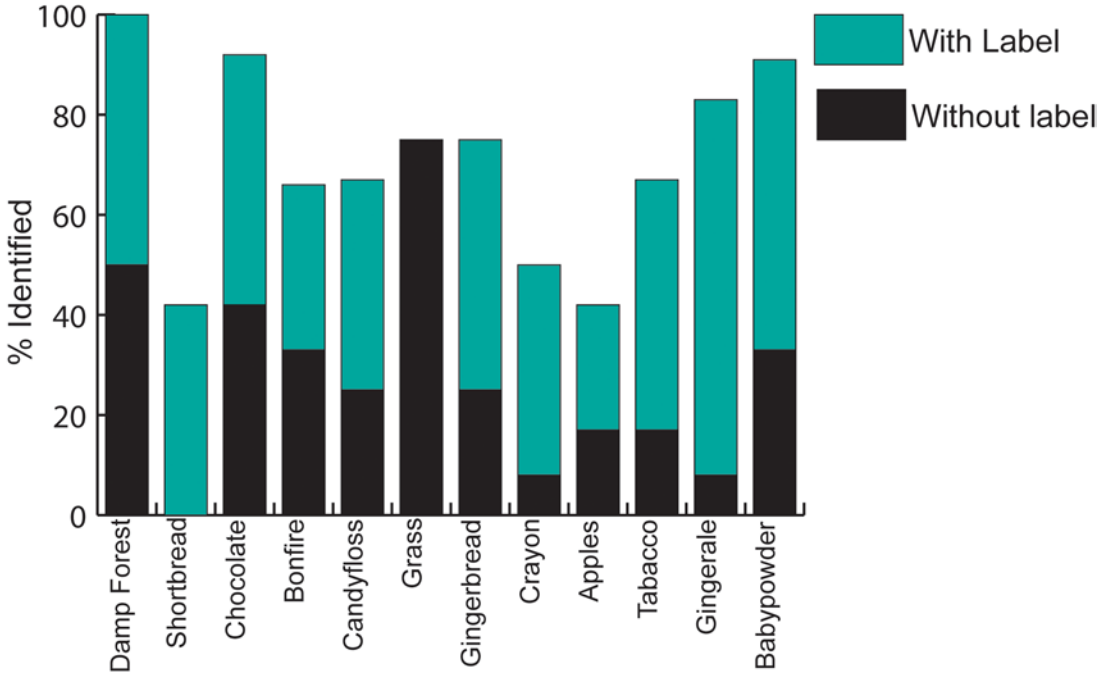

Figure 1: Odours correctly identified with, and without, a verbal label

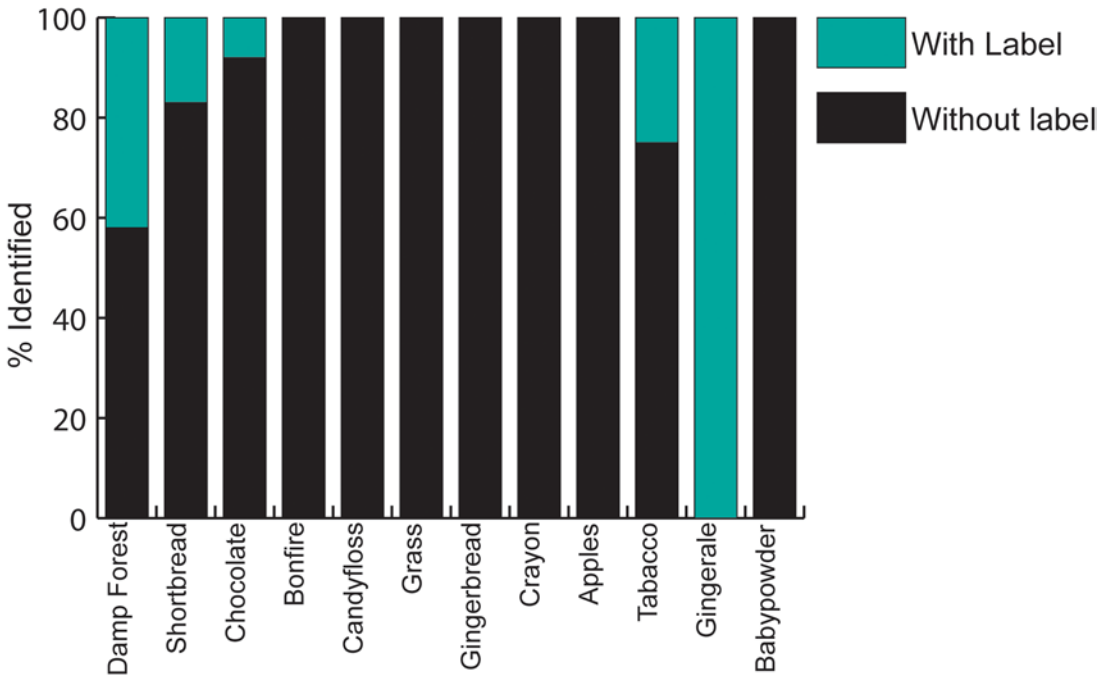

Figure 2: Images correctly identified with, and without, a verbal label

Discussion

An identified limitation of Proust Phenomenon research is the methodological issues surrounding odour idiosyncrasy and a lack of accurate verbal identifiability in comparison to other stimuli. As anticipated, the results demonstrated a significant difference between the ability to verbally identify odours and images without a label. The ability to identify odours with a verbal label did increase significantly from 28% to 71%, however it continued to be significantly impaired compared with the ability to identify images with a verbal label. This difference in ability ensures that, experimentally, it can not be confirmed whether the differences in characteristics of cued-autobiographial-memory are due to differences in stimuli or differences in availablity of a verbal label. However, since a difference in total frequency of memories cued across stimuli, within the main study, was non-significant it can be assumed that a lack of verbal label did not inhibit the production of actual memories, this is despite evidence that the availability of an odour-name has been shown to enhance odour memory (Schab, 1991).

Main Study

Method

Study Design

This experiment used a between-subjects, mixed-methods design with two conditions, each conducted in an interview-style setting measuring the dependent variables of emotion, vividness, evocativeness, age, and frequency with which the memory is thought about. This is achieved by exposure to independent variables of odour and image. Participants were individually exposed to twelve odours or twelve images. If the stimuli cued memory, then a mixture of open and closed interview questions were asked. The interview was self-paced to minimize fatigue and cross-adaptation effects, which may have caused the participant to have a reduced, or increased, response to stimuli. A pilot study was carried out to test fatigue to stimuli, question suitability, and interview length. Following the interview, audio-recordings were transcribed and analysed using both quantitative and qualitative methods. The final stage involved writing up the research using a mixed-methods structure as recommended by Dahlberg, Wittink and Gallo (2010)

Materials

Stimuli

Condition 1 consisted of twelve odours selected from a range of fragrances designed to mimic real-world smells, produced/manufactured by Demeter Inc and CBI Hate Perfume. Reaction to odours depends on the olfactory function of the individual, but also the volatility, purity, presentation and intensity of the odour; it was intended that by selecting commercial products then the presence of these characteristics would be maximised (Coren, Ward, & Enns, 2004). The specific odours were chosen by informal discussion about Proust Phenomenon, current research literature, and odour availability. Prior to interview, three drops of fragrance were decanted into 5ml flat clear acrylic jars with black lids. Each jar was labelled underneath with a small numerical label. No attempt was made to become familiar with matching numerical-label and odour-stimulus to reduce risk of researcher effect. At the end of each experimental day the jars were emptied out and allowed to dry on a rack. Each jar was only ever used for its labelled fragrance.

The full selection of odour semantic labels are listed below:

- Damp forest
- Shortbread
- Chocolate
- Bonfire
- Candyfloss
- Grass
- Gingerbread
- Crayon
- Apples
- Tobacco
- Ginger ale
- Baby powder

In Condition 2, twelve images were selected to complement the range of odours; it was acknowledged that odours and images cannot be completely equivalent therefore effort was taken to match the images without being too leading in context. The images were photographs from the Flickr online image-sharing-community, available for use under a creative commons license. The images were printed in A4

full colour and laminated; a label containing a number was placed on the underside of each image, again no effort was made to become familiar with stimulus number and image.

Apparatus

A digital Dictaphone was used to record all interviews. The researcher followed a printed interview schedule. A laminated visual aid was used for a Likert response to the vividness question to assist the participant in answering more formally following the open questions.

Interview Strategy

The methods were conducted in a controlled semi-structured interview with simultaneous equal-importance weight sequence of qualitative and quantitative methods, termed QUAL + QUAN (Tashakkori & Teddlie, 1998). A mean interview time of 13 minutes was recorded across conditions, excluding introduction and debrief. A semi-structured style involved a pre-planned set of questions to facilitate unique response, and also reflected the different theoretical frameworks used (Bryman, 2006). Immediately following exposure to stimuli an open opportunity was provided to describe evoked memories, followed by a second request to elaborate. Finally, a number of measurement questions were asked, influenced by Rubin, Groth and Goldsmith (1984), which were intended to measure participant's memory experience across emotion, vividness, evocativeness, and age. A question relating to frequency of whether thought about often was added after interview 3 due to oversight. There was no further probing for details.

Participants

Twenty-six participants (19 females) mean age 20.5 (range = 18-47 years, *SD* = 5.4) were recruited from the University of Aberystwyth student population, in a non-probability sample. The majority of participants identified as White British, Welsh or Scottish (81%), 19% identified as Other Asian, Other White and Central or Eastern European ethnicity. All participants spoke fluent English as indicated by their studies on a United Kingdom undergraduate-degree program. There had previously been no significant participant-interaction with the researcher. As an incentive, participating students were awarded one credit towards their own research studies. Demographic information was collected prior to interview using Sona departmental-software.

There were a number of restrictions to participation. Since it was not considered practical to measure olfactory or visual function, on screening participants were asked for any known history of lack of sense of smell, anosmia, or visual impairments not corrected by either glasses or contact lenses. Additionally, since the experiment involved retrieving memories participants, were screened for any sensitivity to memory retrieval and also warned about the use of perfumes. Finally, participants were required to be over 18 and were requested not to smoke in the hour prior to interview to maximise odour sensitivity.

Ethical Considerations

This research adhered to Departmental and British Psychological Society (BPS) (2009) guidelines and was granted ethical approval from Aberystwyth University on

25th October 2011. There were a number of small identified risks to participants; effort was made to ensure that the participants were at no greater risk than they would be in their everyday lives. All identified risks were minimised by appropriate screening, comprehensive informed consent and debriefing information, which included aftercare advice, and by following BPS guidelines for confidentiality and anonymity.

Procedure

This experiment was carried out over several days in November and December of 2011, using the University of Aberystwyth Psychology anechoic chamber, selected due to its consistently maintained environment. Furnishing was limited to an office desk, two swivelling chairs and the experimental materials. Prior to each interview the room was set up in exact duplication with the twelve stimuli and the audio recorder placed on the left hand side of the table. The participants were randomly assigned to either condition based on their scheduled interview time. In the first interview of the day the odour condition was used, followed by the image condition. This rotation of the conditions allowed participants to be randomly assigned to either stimuli and also ensured a period of time for dissipation of any odour residuals.

Participants had received instructions to wait in the main lobby of the building. The researcher greeted them and walked to the anechoic chamber. The majority of the participants had not visited this area before and this gave the researcher the opportunity to build a rapport with the participant prior to reaching the anechoic chamber. Once seated, the participant was asked to read the participant information sheet carefully to decide whether or not to proceed, following which informed consent was confirmed by a signature. The participants were reminded about their anonymous status, indicated by their interview number, and right to stop at any point without reason or prejudice. The audio recorder was switched on; an interview script was read out the participant with detailed instructions about the experiment. In particular, the participant was reminded that they did not need to identify the odour or image and encouraged to disclose memories which immediately came into their minds which were not searched for. The experiment utilised the Galton-Crovitz method, confirmed as an appropriate methodological approach to Proust Phenomenon (Larsson & Willander, 2009). This method exposes participants to a stimuli cue followed by a request to describe any available autobiographical memories (Crovitz & Schiffman, 1974).

In Condition 1, prior to interview, twelve odours, were placed on the experimental table. During each interview, the researcher randomly selected each odour jar, read the label number out loud for the audio tape, then unscrewed the lid and held it for the participant to inhale. The participant was given 3 seconds to inhale the odour. The odour jar was then removed, the lid replaced and placed down on the table. Following exposure to each individual stimulus, the researcher asked if any memories had been stimulated. If the participant answered no then the next stimuli was presented. If the participant answered yes then questioning in accordance with the interview was commenced. Condition 2 followed the same format. Twelve images, prior to each interview, were shuffled and placed image down on the desk. During interview, this enabled the researcher to show each image to the participant and read out the numerical label for the audio tape, without knowing which image is

being presented. The image was shown to the participant for three seconds and then immediately placed face down onto the table. This procedure was followed to attempt to mimic the anonymity of the odours as much as possible. Debrief information was provided to all participants.

Analytic Strategy

Phase One - Preparation

The initial stage of analysis was to transcribe the audio interview files into a text record, this offered the first opportunity since the interviews to become familiar with the data. Play-script transcription style was used, as recommended appropriate for thematic analysis by Howitt (2010). The interviews were transcribed as a whole including both closed and open questions to prevent the risk of losing important data. All evoked memories were considered to be autobiographical for the purpose of the study.

Phase Two- Quantitative Analysis

In the second stage of the analysis, the quantitative data was recorded from the interview transcription documents onto survey sheets. Following which, the data was then analysed by means of *SPSS*, using appropriate statistical tests, including T-Test, Chi-Square and Mann-Whitney. This analysis allowed the comparison of total numbers of memories evoked by either olfactory or visual stimulus, demonstrating whether either stimulus is more or less effective at provoking spontaneous memory. During interview the participants were asked whether the memory evoked any emotional response. Despite research recommendations that emotion is best measured by an 'unpleasant' to 'very pleasant' Likert scale (Willander & Larsson, 2007), it was decided that an open question about emotion would offer more opportunity for diverse response. Within the initial quantitative aspect responces were assigned to a Negative, Neutral, Bitter Sweet, Positive scale, as directed by the data. This enabled the calculation of whether there was any significant difference in the affect expression across both conditions. During the interview each memory was rated low, moderate, high and extreme in a vividness 4-point Likert scale as recommended by Anderson & Shimizu (2007). These responses were transformed into frequency data to determine whether there was any difference in memory vividness between both conditions. Evocative, Yes or No, response data was used to demonstrate difference across odour or image cued memories. Finally interview responses to approximate age of memory formation were transformed into meaningful categories. These categories were influenced by the mean age of the participant sample and known distributions of autobiographical memory, altered to represent age outliers.

Phase Three – Qualitative Analysis

Finally, within the qualitative aspect of the methodology, thematic analysis was conducted on transcription data using guidelines from Braun & Clarke (2006) and Howitt (2010). Thematic analysis provides a way to organise and analyse talk, considering what is actually said rather than any interpretation of the talk, by the identification of major themes. Thematic analysis was considered appropriate for the current research because it enabled the systematic consideration of rich memory experience across the odour and image conditions. Initially the analysis treated

each condition as a separate group and sought to identify broad themes within the oflactory and visual memory descriptions. The identification of themes is an interpretative process and therefore qualitative research is more likely to be influenced by the researcher. Therefore this research attempts to be as transparent as possible in its method and development.

Braun and Clarke's (2006) method of thematic analysis aims to strengthen the process, thus maximising the validity of themes to the respective data set. The process involves six stages which are sequential, but also involve overlap and revisiting. The foundation stages of becoming familiar with the data were described in Phases One and Two. In the next stage of analytic effort, the researcher took a line by line approach to coding. This involved describing expressed memories in a succinct way with broad descriptions of emotions, places, and events for example. The extracts relevant to coding were then copied over onto charts as recommended by Howitt (2010). This enabled the development of lists which were transposed into mind-maps and fitted into loose potential themes of grouped codes. Additionally post-it notes were used to record interesting directions of the talk. Effort was taken to try and match extracts to themes as accurately as possible and the data and codes were revisited several times to ensure a goodness of fit. For example, initially a sense of sentimentality was coded. However, as the coding continued this was developed into a sense of nostalgia. The data set involved large chunks of irrelevant data. For example, if the researcher was asking a closed question relating to the qualitative data, these responses were ignored unless the participant elaborated on the required response, in which case the data was treated as part of the interview data set. A principal requirement of developing a thorough thematic analysis is providing evidence of the goodness-of-fit of themes across the entire data set (Howitt, 2010). The initial stages of the code development were entirely data driven. However, as the codes began to gather into themes, thought was given to how this relates to current knowledge of Proust Phenomenon which led to an increased understanding of the data. In terms of reporting the themes, effort was given to expressing the prevalence of a theme within the main report. The final stage of the design involved drawing up thematic charts (Figures 17-22) with several examples from each identified theme deemed as a good fit.

Results

Quantitative Results

This research hypothesised that odour cued memories would be more emotional, evocative, vivid and older or thought about more frequently than memories cued by images**.** 13 participants from each condition were exposed to either 12 odours or 12 images. An alpha level of .05 was used for all statistical tests. In total, 312 image and odour stimuli were presented, resulting in 174, a response rate of 56%). 82 (or 47%) were cued by odour, in comparison to 92 (or 53%) cued by image. On average, participants experienced more memories when cued by image (M = 7, SD = 1.87) than when cued by an odour (M = 6.31, SD = 2.81). This difference was non-significant $t(20.89) = -.74$, $p > .05$, two-tailed; while the magnitude of the differences

in the means (mean difference = -.69, 94% *CI*: -2.64 to 1.26) indicated a small effect (eta squared = 0.02). Levene's test for equality of variances was found to be violated $F(1, 24) = 4.39$, $p = .047$. Therefore a *t* statistic not assuming homogeneity of variance was used. Figure 3 illustrates the percentage memories evoked by each stimulus; 'bonfire' was shown to be most effective at evoking image cued memories, whilst 'shortbread' was shown to be most likely to evoke an odour cued memory.

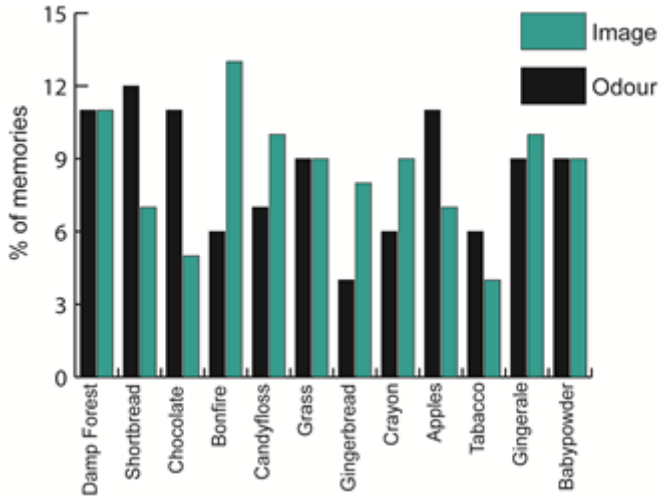

Figure 3: Percentage of total memories evoked by each stimuli

Across both conditions most memories were identified as eliciting a positive emotional response, odour (60%) and images (64%). The least-frequently evoked emotions were identified as negative, as illustrated in Figure 4. A Chi-square test for independence (with Yates Continuity Correction) indicated no significant association between stimulus type (odour or image) and evoked emotion $\chi^2(3, n = 174) = 6.65$, $p = .08$, *phi* = -.08.

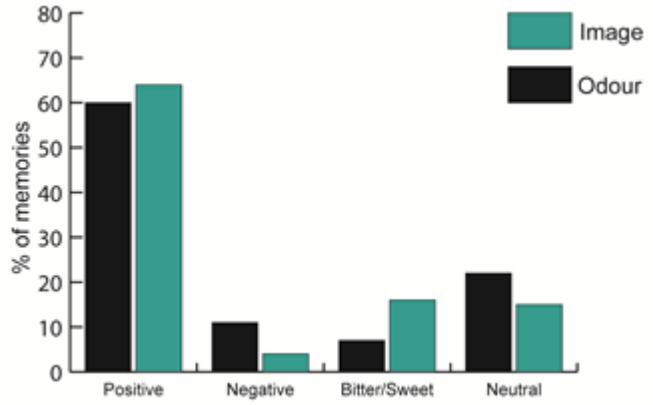

Figure 4: Effect of memories evoked for each stimuli in %

Across both conditions most memories were identified as being high in vividness, odour 42% and image 40%, as illustrated in Figure 5. A Mann-Whitney U Test, one-tailed, revealed no-significant difference across the groups cued by odour (*Md* = 2, *n* = 81) and images (*Md* = 3, *n* = 92), *U* = 3281.5, *z* = -1.32, *p*= .09, *r* = 0.1 indicating a small effect. In addition 68% of memories cued by odour were considered evocative compared with 73% of memories cued by odour. A Chi-square test for independence (with Yates Continuity Correction) indicated no significant association between stimulus type (odour or image) and memories identified as evocative χ^2(1, *n* = 174) = .43, *p* = .51, *phi* = -.05.

The age the memory was recorded and transformed into groups ranging from oldest-old to recent. Across both conditions most memories were identified as relating to near past (odours 36% and images 27%), differences between the groups were not statistically significant (P = 1, Fisher's exact test) as illustrated in Figure 6. In addition, most memories (odours 63%, images 61%) were considered not to have been thought about often, a Chi-square test for independence (with Yates Continuity Correction) indicated no significant association across stimulus type χ^2(1, *n* = 117) = .04, *p* = .84, *phi* = -.84.

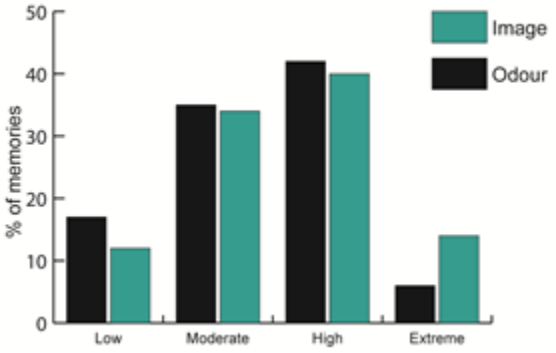

Figure 5: Vividness of memories evoked for each stimuli in %

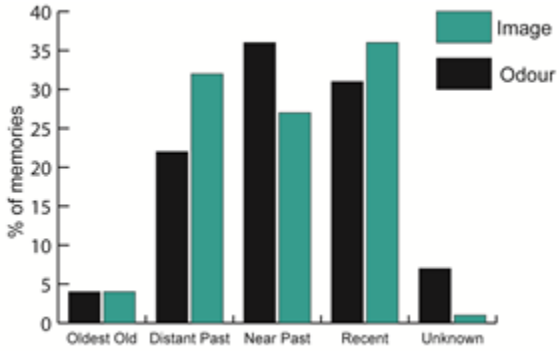

Figure 6: Age of memories evoked for each stimuli in %

Qualitative Results

A thematic analysis was conducted, allowing for the identification of reoccurring themes within evoked memories. The memories cued by both odour and image contained information consistent with autobiographical memory, what the person was doing and why, where they were and with whom they were doing it with (Bernsten, 1996) (Conway & Pleydell-Pearce, 2000). The purpose of the thematic analysis in this research was to identify differences across the expressed memories. These themes are illustrated in Figure 7. As would be anticipated the focus of the memory tended to be anchored to the verbal descriptor of the image. For example, an image of a bonfire resulted in many memories about Bonfire Night, operating in contrast to odours. For this reason, the focus of the analysis was the arrangement of the memory rather than specific details. These themes will now be discussed in detail along with representative extracts of interview talk.

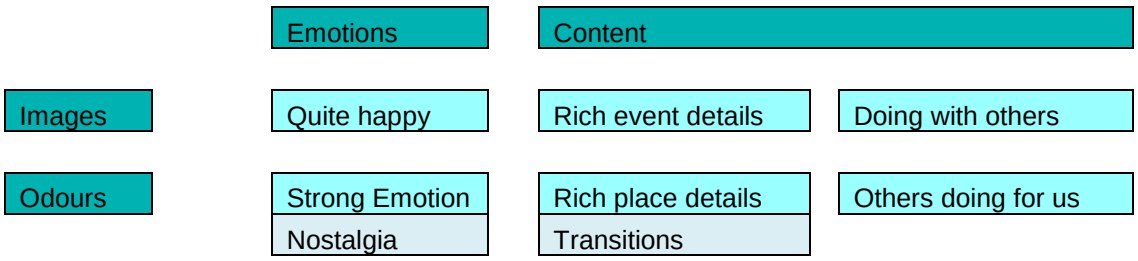

Figure 7: Themes across odour and image evoked autobiographical-memory

Discussion

This study used a mixed-method approach to elicit and compare autobiographical memories evoked from odour and image stimuli to provide evidence of Proust Phenomenon and, furthermore, the unique attributions of autobiographical odour memories operating within a Multiple Memory System. There was shown to be no difference in the ability of image or odour, despite a lack of verbal label for odours, to cue autobiographical memory. This did not support Chu and Downes (2000) finding that odour memories are superior cues of autobiographical memory, and in contrast, a lack of odour label did not obviously effect memory stimulation. Although no formal attempt was made to assess retrieved memories as autobiographical, their expression was consistent with Conway and Pleydell-Pearce's (2000) criteria that memories should speak about who did what, where, when and why.

The results demonstrated no quantitative difference across memories evoked by either odour or image, when measured by emotional category, vividness, and evocativeness, age or time last thought about. This initial result would suggest that the qualities of Proust Phenomenon are not a unique experience and instead a product of associative memory operating across the senses. However, a qualitative

enquiry of the transcribed memories demonstrated five emotional and contextual themes identified as relating to each stimulus, as illustrated in Figure 7. These themes will now be discussed in combination with the quantitative results to provide substantiate evidence for Proust Phenomenon within the context of previous research; followed by the study limitations, implications and recommendations for future research.

Strong Emotion and Nostalgia versus Quite Happy

The quantitative results demonstrated that most memories, odour (60%) and image (64%), facilitated a positive emotional response with no significant difference across the groups. This is consistent with autobiographical memory research, defining that spontaneous memory in a typical population is more likely to be positive, functioning as a protective mechanism (Bernsten, 1996), and was also likely influenced by the pleasant nature of the stimuli. This positive alignment was also reflected within the thematic analysis, but with additional differences observed relating to both emotional strength and affect expression. Throughout the interviews, odour memories were expressed as stronger consistently across the data set, on occasion evoking physical responses such as laughing or tearfulness. In contrast, the image memories are described using more passive statements like ‘quite happy’ or ‘happy, yeah’, only three image memories across the entire data set evoked a stronger response of ‘really happy’ and ‘very positive emotions’. It is also noteworthy that no evidence was shown to support the claim that odour memories are experienced only on a positive or disgust continuum, as suggested by Croy, Olgun and Joraschky (2011), with odour memories across the data-set being described using complex emotional words such as curious, surprise, comical, disgruntled and intimate. Figures 8 and 9 illustrate these thematic differences.

> Yes, very very, I feel very intimate feelings, a lot of happiness, that sensation of love.

Figure 8: Strong Emotion theme within odour memory – P19

> The ….. House in early spring last year this year, he had a bonfire and it was going well until it kind of fell on us, yes [Emotion?].. . . urm kind of happy I guess.

Figure 9: Quite Happy theme within image memory - P4

As a sub-theme many odour memories were identified as having nostalgic qualities, identified as ‘personal contemplation of a valued experience in the past’. Nostalgia is a secondary emotion, unlike fear or grief, which relies on our understanding of the world and is a gentle reminder rather than overwhelming force (Dickinson & Erben, 2006, 223). Within the odour interviews many participants explicitly looked back on their past with a yearning, talking of ‘back home’, in addition often expressing emotions referring directly to home, for example, feeling ‘warm homely’ or ‘homely comforting’. It is notable that most of the participants interviewed were away from home, potentially influencing their unconscious memory retrieval. However, nostalgia was not shown as a prominent feature across image memories. In Figure 10 a participant has recalled a memory from her early school life, illustrating nostalgia.

> A little bit sentimental actually, there are points in my life when I'm just like oh I wish I could go back to this here, just being careless just having fun being little scientist, you know create, it was very nice this, I'll never forget this period because it was , it left a mark

Figure 10: Nostalgia within odour memory – P22

This sense of nostalgia links to another aspect of Proust Phenomenon folk-belief, that of evocativeness. Studies demonstrating support for this element have suggested that autonoetic sensation, facilitated by the olfactory, hippocampus and prefrontal pathways, provides a feeling of being taken back in time (Herz & Schooler, 2002; Herz, 2004). This study replicated Rubin, Groth and Goldsmith (1984) by asking whether a memory was evocative, taking a participant back to an original time and place and demonstrated no quantitative difference across the conditions despite this presence of nostalgia within odour memories.

Rich Place Details versus Rich Event Details

When Marcel Proust described his olfactory-induced autobiographical account of a past long gone, its considered uniqueness is in the extensive detail, an element which has been interpreted, to date, by a measurement of vividness. Within the current study quantitative-analysis showed a non-significant difference in memory vividness across the conditions. This finding supports previous scientific enquiry into Proust Phenomenon (Rubin, Groth, & Goldsmith, 1984); (Herz & Schooler, 2002); (Herz R. , 2004). However, in contrast thematic analysis demonstrated a difference in memory content across-conditions providing avenues for further enquiry.

A theme of Rich-Place-Detail reflected the many odour memories which generated details with place as the main focus. Although, as typical of autobiographical-memory both conditions contained information relating to location, odour memories demonstrated particular differences. Firstly, many of the odour memories were place orientated, containing rich peripheral details without necessarily including an event or activity. Frequently, the participant also gave the impression that they may be 'lost within' the memory; providing details as they were remembered rather than to a recalled script. Odours are demonstrated as more effective as reminders if they are recognised as novel or distinctive (Aggleton & Waskett, 1999; Herz R. S., 1998) and many of the odours were experienced as novel; the smell of a particular tree from home, or a shampoo or perfume which was used as a child, potentially demonstrating an proactive interference effect as suggested by Miles and Bernsten (2011). This aspect could also be considered with Chu and Downes (2002) differential encoding bias hypothesis, defining that olfactory details are peripheral in nature and are not required for the meaning or interpretation of an event. The following extracts are provided to illustrate these attributes. In Figure 11 the participant talks in detail about a location yet does not divulge why he was in France, and within Figure 12 the participant expresses surprise at recalling a memory from around age four which had not been thought of recently. In contrast, although memories cued by image also contained rich detail the focus was about an event, what happened, where and to who. In Figure 13, a typical image memory, a participant recalls a detailed memory, beginning with a clarification that it is not unique, telling the interviewer what happened, who with and why.

> I see a French shop next to a church in Paris with a pavement of very rough, there are works, they're building there repairing the church right next to it and it's this sort of, the shop is kind of the Provence style shop and I'm walking around it and smelling everything because I like this kind of style, this sort of picturesque furniture and all of these house decorations

Figure 11: Rich Place Detail within odour memory – P16

> Mmm yeah old, like a basement full of old books, it reminds me of a basement full of old books where my Grandparents used to keep their books, I've been there only once but I remember the smell, just the dark room with the small window at one side, and then half not really seeing the books but knowing they're there.

Figure 12**:** Rich Place Detail within odour memory – P23

> yeah, this is another beginning of University memory, one evening we had this, I think during Freshers week, so in the September, one evening we had decided not to go out, and that we were gonna have a fire on the beach instead and some of the people from our apartment found loads of used wood in a skip and we went to the beach and had a fire

Figure 13: Rich Event Details within image memory – P13

An observed sub-theme, and quirk, of odour memories involved transitional information as the person mentally described what the odour reminded them of. Within the odour condition many of the memories related to shops, bathrooms, and gardens. In particular, these memories mentioned a transition between environments, walking through doors for example, as evidenced in Figure 14. Again, if this is considered using Chu and Downes (2002) differential encoding bias hypothesis it could be representative that the odour was coded most strongly as the person entered into the odour.

> Just at the beginning of the corridor and basically just walking in with my mother and seeing the enormous queue that I had to wait through to get to the doctor

Figure 14: Transitions within odour memory – P23

Others Doing For Us versus Doing With Others

The final themes to be developed from the data concern a difference involving the relationships within the memories. Odour memories demonstrated a tendency to involve people doing things for us, in particular bonded relationships, mother, grandmother, father and frequently involved intimate actions like feeding, bathing, or cuddling. This supports studies of olfactory behaviour indicating that odours are linked to the people around us. Children, for example, have demonstrated that 77% are aware of the smell of close relatives and 71% recognise the smell of their parents' car (Ferdenzi, Coureaud, Camos, & Schaal, 2008). In contrast, memories cued by image tended much more to talk about friendships, and what we were doing with other people, for example socialising or going on holiday. A useful way of considering this data might be Conway and Pleydell-Pearce (2000) Model of Autobiographical Memory which closely links a person's concept of self within the

organization of autobiographical memory. Potentially demonstrating that the organization of memory is stuctured such that sensory input is relevant to alternative concepts of the self.

> It reminds me a little bit, it's sort of a really really unclear memory but I can imagine sort of something that my Grandmother used to put under my pillow, I'm not sure if it's maybe lavender-ish type of smell but that's what I'm imagining, it's my Gran sticking it under the pillow

Figure 15: Others Doing For Us within odour memory – P27

> Erm, it just reminds me about when I went to …… in my home town and we would be climbing up the hills and one of my mates fell down one slipped all the way down, stop laughing {to self}there's like loads of trees err he just fell from the actual, he was trying to look down a little bit and explore and then he slipped and he slipped all the way down this like muddy hill and then we had to walk through the erm through the forest with him being muddy and then all through town it was pretty funny

Figure 16: Doing With Us within image memory – P3

As a final note, the present research demonstrated no significant difference in age of memory or frequency of last thought about experienced across odour and visual stimuli. This is in contrast to previous evidence which demonstrates an earlier bump in autobiographical memory. However, it should be recognised that the age of participants used in the study was potentially not conducive to demonstrating this difference.

Limitations

Investigating Proust Phenomenon is problematic, as previously detailed within the norming study section. A second limitation of the research considers the idiosyncratic nature of odours. Odours are complex stimuli of which knowledge is based on previous oflactory experience and influenced by contextual issues; other odours in the environment, the weather or season in which the odour is experienced, and individual differences in dispositions to experience positive and negative affect (Doty R. L., 2001); (Watson & Clark, 1984). The final limitation to be considered is that there is no evidence that the observation of voluntary memories is equal to true involuntary memories. Equally, it is acknowledged that the interview descriptive process inexplicably links the episodic memory event to semantic memory as the participant searches for the language to express what they are experiencing (Tulving, 1972); Berntsen, 1998).

Conclusion

This study utilised a mixed-method approach, maximising the use of retrieved data, to explore Proust Phenomenon in an experimental setting. This approach allowed for the elaboration, contrast and support of findings across quantitative and qualitative data. It was demonstrated that complex memories can be stimulated from odours, even those difficult to identify, at a similar rate to images. When quantitative results determined no-difference across conditions, then a themes of Strong Emotion, including nostalgia, was used to elaborate, providing support for odour-

cued memories being stronger in emotional experience, potentially with an increased capacity to elicit nostalgia or aspect of MTT. The quantitative measurement of vividness or evocativeness supported previous research, determining that there is no difference between odour and image memories. Thematic analysis was able to somewhat contradict these findings by exploring differences within the content of the memories, in particular that odour memories are place focused whilst image memories are event focussed. These findings are useful when considering broader memory perspectives, for example Chu and Downes' (2002) differential encoding bias hypothesis and Miles and Bernsten's (2002) proactive interference. Overall, as concluded by Herz & Schooler, (2002), odour induced memories influence the manner in which we talk about our past. As a final point, thematic analysis was able to demonstrate the self functioning differently, across image and odours memory, offering the potential for further scientific investigation (Conway & Pleydell-Pearce, 2000).

Despite limitations, research into Proust Phenomenon offers the potential to learn more both about olfactory and autobiographical-memory structure. The distinction about whether these memories are different from the involuntary memories of other senses holds theoretical importance in determining how memory operates as a multiple systems and sub-structures, providing evidence for memory theory, and also avenues of enquiry for clinical conditions such as PTSD and OCD. There are a number of future avenues for research, in particular, a continuation into exploring differences in the language of odour-cued autobiographical-memory and across other sensory stimuli such as touch or auditory The development of appropriate measuring tools would allow further investigation into this fascinating phenomenon, which whatever contradictions thrown up by research into Proust Phenomenon, are nonetheless, considered and experienced as 'real' by many people.

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