Does an induced emotional state affect how we resolve lexical ambiguity?

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ABSTRACT

Research has shown that the mood or emotional state of an individual can affect how lexical ambiguity is resolved. This study focused on a particular group of words that sound the same but differ in spelling and meaning, namely homophones. Homophones often have a valenced meaning (i.e. negative or positive) and a neutral meaning, for example die/dye and dear/deer, this enables the role of emotions to be investigated. Sixty participants, aged 18-25, were randomly assigned to a control group or experimental group. In the experimental groups, either a negative or positive mood was induced and maintained through affect-related images and valenced sound clips, respectively. Using a word association task in which homophones were presented orally, participants chose one of two words they most associated in meaning with the target homophone. Participants completed an Affect Grid pre and post-experiment. An interaction between the participant's induced mood and choice of homophone valence was found, but significance was only reached for the positive mood group; they were more likely to choose the positive related meaning of a positive/neutral homophone, and the neutral meaning of a negative/neutral homophone. The results indicate that the mood induction for the positive mood group influenced the choice of meaning in the word association task. This differs from previous findings and possible explanations are discussed. However, this study adds to the growing body of work showing that mood can have an important effect in resolving lexical ambiguity.

KEY WORDS	EMOTIONAL STATE	HOMOPHONE	INDUCED MOOD	AFFECT GRID	WORD ASSOCIATION TASK

INTRODUCTION

The English Language contains many words that are ambiguous and have multiple meanings ("lexical ambiguity"). For example, the word "bark" can refer to the "sounds of a dog" or the "outer covering of a tree". The process of disambiguating words is central to day-to-day cognitive functioning and is a special case of the more general problem of word recognition. Typically, there are two main processing questions regarding what happens when we come across an ambiguous word: firstly, how do we choose the appropriate meaning? Secondly, at what stage is context used to resolve lexical ambiguity? Words are not typically recognised in isolation, but within a context. This can be a prior sentence to the ambiguous word that primes a certain association or a particular context such as mood.

Early researchers worked within the framework of three different models to investigate the resolution of ambiguity. Foremost among these models was the context-guided single-reading lexical access model (Glucksberg, Kreuz, & Rho, 1986; Schvaneveldt, Meyer, & Becker, 1976; Simpson, 1981) which states that context restricts the access process, normally allowing only the relevant meaning to be accessed. It is not always clear how context can provide such an immediate constraint. Secondly, the ordered access model (Hogaboam & Perfetti, 1975) states that all senses of a word are accessed but in order of their individual meaning frequencies. Each sense is then checked against the context to see if it is deemed appropriate. The final model, the multiple-access model (Onifer & Swinney, 1981; Swinney, 1979; Tanenhaus, Leiman, & Seidenberg, 1979), states that all senses are activated when an ambiguous word is encountered. The appropriate meaning is then selected when the context permits.

Some early evidence provided support for the multiple-access model, and some for the selective access model. However, it was suggested that the results were extremely task-dependent (MacKay, 1966; Hogaboam & Perfetti, 1975), some tasks reflected processing times well after the ambiguity had been processed and some tasks were sensitive to a multitude of other variables. This led to the creation of a pioneering task that probed lexical access in real time (Swinney, 1979). The act of resolving ambiguities was considered to be an autonomous, fast and obligatory process. A cross modal priming task (CMPT) was used. Participants had to respond to a visual lexical decision task (a string of letters flashed on the screen, priming participants to a particular meaning of the ambiguous word) while listening to auditory material (a recorded sentence containing the target lexically ambiguous word). Swinney claimed that if participants activated both meanings of the ambiguous word simultaneously then response times should be the same regardless of the priming activity. Swinney's results supported the theory of multiple-access; context is subsequently used to select the correct meaning.

Building on this work, Jastrzembski (1981) found a surprising ambiguity advantage within lexical decision tasks. Individuals were faster to make lexical decisions about ambiguous words that had a high number of meanings versus ambiguous words with a low number of meanings (i.e. many vs. few). The metric used was the number of dictionary entries. Ambiguous words possessed more than 10 meanings (e.g. fudge), were compared with ambiguous words with less than 4 meanings. This advantage was not found within other tasks, such as eye-movement measures. This raises questions, such as whether ambiguous words benefit from having multiple entries in the lexicon. For example, lexical decision tasks showed a processing advantage for words with multiple related senses, in comparison to unambiguous words. This phenomenon is known as the ‘ambiguity effect’ (Azuma & Van Orden, 1997).

Lexical ambiguity can typically be divided into two categories: Homonymy and Polysemy. Homonymous words have two or more unrelated meanings (for example “bark”, as explained above). Polysemous words have a single meaning but multiple related senses (for example “film” - as in the physical reel, the complete material watched on media or a thin layer/covering on something). There is some evidence that homonymous and polysemous words are processed differently (Klepousniotou, 2002). Later research found a difference within ambiguous words themselves. Polysemous words are processed faster than frequency matched unambiguous control words, whereas homonymous words show no advantage. Since the multiple senses of polysemous words are related, they are not incompatible with each other, therefore, the immediate selection of a sense is not necessary for processing to continue. In the case of homonymy, all meanings are unrelated, therefore one meaning must be chosen before further processing which is time consuming (Klepousniotou & Baum, 2006). Research in this area has focused more heavily on homonymy. Some studies have focused on a particular subcategory within homonymous words, namely heterographic homophones.

A homophone is a word that is phonologically (i.e. sounds) the same as another word but differs in meaning. Homophones that are spelt the same, (e.g. “bank” - a place for money or a place beside a river) are called homographic homophones. Homophones that are spelt differently are called heterographic homophones (e.g. pear/pair). Heterographic homophones often have an affect-related meaning and a neutral meaning, for example die/dye or peace/piece. This enables the role of emotions to be investigated in resolving lexical ambiguity. Such an effect was predicted by Bower (1981; 1987; 1991), the emotion network model, in which emotions are organising units in a semantic network of cognitive processes such as attention, and word processing. When an emotion unit is activated, the activation spreads to other concepts, potentially the semantic codes for emotion-congruent words. If the affective meanings of homophones are activated by the experience of emotion, then someone in an emotional state should be more likely to access the emotional meaning rather than the neutral one.

Past research in this area by Blanchette & Richards (2003), Halberstadt, Niedenthal, and Kushner (1995) and Nygaard and Lunders (2002), as well as more recent research such as Sereno, Scott, Yao, Thaden, and O’Donell (2015) and Gordon, Chesney, and Reiter (2016) looked at the role of emotion/mood in resolving lexical ambiguity in a range of populations: clinical and undergraduate students. A variety of methodologies have been used: spelling task (Halberstadt et al., 1995) and lexical decision task (Sereno et al., 2015). However, some methodologies weaken the ability to generalise findings. Research has not always compared the different categories of emotion words: positive, negative and neutral. Typically, only two out of the three listed are investigated. Sometimes, words eliciting a particular emotion such as happiness, sadness, anxiety

(Blanchette & Richards, 2003) and depression (Dearing & Gotlib, 2008) are investigated.

The study of clinically anxious (high/low trait anxiety) individuals within this area of research has generally shown consistent results. Anxious participants were more likely than non-anxious participants to interpret ambiguous information in a threatening manner, within a sentence (Eysenck et al., 1991) and a spelling task (Matthews et al., 1989). However, Blanchette and Richards (2003) conducted research by inducing anxiety on a group of healthy individuals and found that those in the anxiety-induced group were influenced to a greater extent by context, than those in the control condition. This led to mood-incongruent effects; an anxiety-induced participant was more likely to choose the neutral interpretation of potentially threatening information. This discrepancy poses the question of whether the effects of mood, and anxiety, go beyond a simple emotion-congruent effect (Bower, 1981; 1987; 1991). Emotion alone may influence the way in which information is used to resolve lexical ambiguity. This has been shown on a population known to be at an increased risk of depression, daughters of depressed mothers (Dearing & Gotlib, 2008). It was investigated whether these at-risk daughters showed a cognitive bias to interpret ambiguous information negatively. They were compared against a control group of daughters with 'never-disordered' mothers at information processing tasks, in which their interpretations of emotionally ambiguous stimuli were evaluated. Results provided further support for cognitive vulnerability models of depression. Daughters of depressed mothers interpreted ambiguous words more negatively and less positively than the control group.

A more recent study (Gordon et al., 2016) looked at emotion dysregulation in undergraduates and its influence on resolving lexical ambiguity. Since incidental emotions alter the way one interprets ambiguity (Matthews, 2012), regulating our emotions is not only crucial for adaptive functioning, but may influence how one interprets ambiguous information around them. In Gordon et al.'s participants were either in an anger-induced or a control mood group. A mood was induced through the autobiographical recall of anger-inducing events, such that when recalling the event participants still experienced strong frustration. They were told to disambiguate sentences, then asked to reappraise their mood, and to determine whether they felt it altered their interpretations. The results supported the prediction that individuals in an angry mood would make more negative interpretations of an ambiguous scenario than those in the control group. One's reappraisal of their mood encourages reflection of any cognitive bias and whether it acted as a subliminal context to resolving lexical ambiguity.

Research has shown that a temporary mood can be induced effectively within a laboratory setting (Shachter & Singer, 1962), despite emotion and cognition being recognised as mutually exclusive constructs for many years. An early technique involved reading self-referent statements which progress from a relatively neutral mood to a negative mood (Velten, 1968). Other techniques also include autobiographical recall, watching film-clips and/or listening to music. The latter is generally preferred in relation to word recognition experiments. In such inductions, participants would firstly be asked to listen to a piece of music determined by the experimenter to elicit a target mood. This is followed by a word recognition task, where music can be played in the background (Small, 1985; Halberstadt et al., 1995). Unfortunately, many of the 'positive' or 'negative' music pieces used in studies are well known, for example Mozart's *"Eine Kleine Nacht Musik".* Also, an individual's personal affective associations with the music may or may not be congruent with the desired mood being induced.

It has been suggested that multiple inductions contribute additively to a mood (Gilet, 2008). A successful combination of mood induction methods use an initial induction that occupies foreground attention and a second method that contributes to a congruent background atmosphere. Two methods have been widely used in literature related to lexical ambiguity. Firstly, film clips. Uhrig et al. (2016) reviewed the emotion elicitation competency of images and films, both accepted as valid methods of mood induction. It is often assumed that the effectiveness of films exceeds those of images, this statement has not been directly investigated. Results found that images were as effective at eliciting positive emotions, but film clips were less effective in modulation of negative valence. Although, significance was only reached for negative valence rating, questioning whether it is easier to experimentally manipulate a negative affect state than a positive one. This is supported by a meta-analysis of 11 mood induction procedures (Westermann et al., 1996). Mood induction methods utilising images do not involve deception and can be easily standardised, for example the International Affective Picture System (IAPS) is available for public research since 1992 (Lang et al., 2005).

The second method is the use of sound clips. The auditory stimulation of sounds such as 'exposure to nature' (e.g. birds tweeting) and environmental noise (e.g. busy city) has been shown to effect recovery after experiencing psychological stress. Physiological measures, such as skin conductance levels, showed that recovery tended to be faster during natural sound than urban noise. This suggests that nature sounds facilitate recovery (Alvarsson et al., 2010). It has been posited that faster recovery is related to positive emotions, evoked by a nature sound.

The current research investigated the possibility that like semantic context, emotional state guides the resolution of lexical ambiguity. Many tests of Bower's model (1981; 1987; 1991) have reported emotion-congruence effects of specific emotional categories, such as happiness and sadness, and recently anger in word processing. The present study extended research to broader emotional states of 'positive' and 'negative', to allow direct comparison between research and allow for appropriate generalisation of results. Typically, a mood is induced using music, however within the present study, two novel mood induction techniques were combined to contribute additively to a mood, the viewing of images and listening to sound clips respectively.

THE PRESENT STUDY

This study aims to build on existing research investigating how mood effects how lexical ambiguity is resolved by focusing on a particular group of words that sound the same but differ in spelling and meaning, known as homophones. Homophones often have a valenced meaning (i.e. negative or positive) and a neutral meaning (e.g. die/dye and dear/deer). A homophone word association task was used to investigate how an induced mood may influence the interpretation of ambiguous stimuli.

Participants were exposed to either a negative, positive or control mood induction. A mood was measured, induced and maintained in a novel way, this helps the study offer additional interest. Participants were then presented with a word association task in which they heard ambiguous target words. These words could be of three types: negative/neutral (e.g. die/dye), positive/neutral (e.g. peace/piece) or neutral/neutral (e.g. allowed/aloud).

Based on existing research findings, an interpretation bias was predicted, typically referred to as an emotion-congruence effect. This is an interaction between emotional state (mood) and homophone valence. It was expected that when homophones with a positive and a neutral meaning were presented, participants in the positive mood induction group would be more inclined to choose the positive word association of the homophone than the neutral. Similarly, it was expected that participants of the negative mood induction group would be more likely to choose the negative word association when negative/neutral homophones were presented.

METHOD

Participants

Participants were students aged between 18-25 years, studying at a university within the United Kingdom with English as their native language. Participants were recruited by one of four methods: a block email asking for voluntary participation, snowball recruitment by previous participants, opportunity sampling or informal verbal contact. Participants were notified that taking part was entirely voluntary and that they could withdraw at any point before data analysis.

Participants were randomly assigned to one of three groups: negative affect, positive affect or control group. All groups comprised of 20 participants - 60 in total for the study, 24 males and 36 females.

Design

The study used a 3 (mood induction: negative, positive, control) X 2 (homophone type: negative/neutral, positive/neutral) mixed design. Mood induction was a between-participants factor, whereas homophone type was a within-participants factor.

The dependent variable was the valence meaning of the choice of word (negative/neutral, positive/neutral) chosen on the word association task.

Counterbalancing was established by a computer-generated randomisation sequence which controlled the presentation order of the mood induction images and the homophones.

Materials

Mood Measure: Affect Grid

Prior to any mood induction procedure, all participants provided ratings of their current mood using an Affect Grid (Russell et al., 1989). This mood measurement is a scale designed to assess affect along the dimensions of pleasure-displeasure and high energy-low energy.

Mood Induction: Images

The images used were selected after utilising the search tool within Google. Phrases such as "aggressive animals, scary insects", "smiling animals" and "animal silhouettes" were used. From this search, an initial 30 images were selected for each group. These images were then piloted on three undergraduates, as to the most appropriate selection of stimuli to induce the following moods: negative-affect, positive-affect and control group. Images were rated on a 5-point Likert scale, images scoring 3 and above were deemed appropriate for use, from this, 25 images for each group were chosen.

Those in the negative affect group were shown mildly unsettling images of either animals bearing teeth or close-ups of vicious insects and bugs. Those in the positive affect group were shown pleasant images of smiling animals. Those in the control group were shown animal silhouettes (see *Figure 1* for examples of images shown).

Figure 1: Example of image shown in Negative Mood Induction Group, Positive Mood Induction Group and Control Group

Mood Maintenance: Sound Clips

In accordance with previous studies, music clips have been shown to induce a temporary mood. Following a review of research in this area (Alvarsson et al., 2010), a nature sound of ‘birds tweeting’ was presented in the positive affect group and an urban noise of ‘a busy city’ was presented in the negative affect group. Both sets of stimuli were found using YouTube.

Homophone Word Stimuli

Homophone stimuli was selected from studies that had a similar objective (Blanchette & Richards, 2003; Dearing & Gotlib, 2008; Gordon et al., 2016; Halberstadt et al., 1995; Sereno et al., 2015). The selected homophones were categorized into three groups depending on the different meanings. The first group used 15 homophones with both negative and neutral meanings (e.g. die and dye). The second group used 15 homophones with both positive and neutral meanings (e.g. peace and piece). Whereas, the third group used 20 homophones with two neutral meanings (e.g. jeans and genes). This latter group of homophones acted as filler words to conceal the experimental nature of study. All homophones were recorded in a female voice.

The presentation of the associated words of the homophone was also counterbalanced. For example, the “positive” word association of the homophone would not always appear on the left-hand side of the screen.

A list of the homophones used in the present study can be found below in *Table 1, Table 2, Table 3 and Table 4*, along with their respective word frequency.

Table 1: List of word stimuli for negative/neutral homophones, along with Respective word frequency

Homophone (negative)	Frequency	Associated word	Homophone (neutral)	Frequency	Associated word
bury	4.07	death	**berry**	3.80	fruit
die	4.90	funeral	**dye**	3.49	hair
pain	4.85	injury	**pane**	2.93	window
patients	4.70	illness	**patience**	4.06	calm
skull	4.04	brain	**scull**	2.62	oar
court	5.10	arrest	**caught**	4.96	catch
tense	4.08	awkward	**tents**	3.68	camping
serial	3.67	murders	**cereal**	3.65	breakfast
break	5.23	smash	**brake**	3.84	car
flu	3.85	cold	**flew**	4.14	alleviate
groan	3.04	sigh	**grown**	4.73	height
nit	3.12	insect	**knit**	3.64	sew
slay	2.92	execute	**sleigh**	3.31	Christmas
weak	4.33	debilitated	**week**	5.66	season
fined	3.74	penalise	**find**	5.89	acquire
Mean	4.11		**Mean**	4.03	

Table 2: List of word stimuli for positive/neutral homophones, along with respective word frequency

Homophone (positive)	Frequency	Associated word	Homophone (neutral)	Frequency	Associated word
bridal	3.22	nuptials	**bridle**	2.84	horse
dear	5.08	close	**deer**	4.26	animal
fair	5.16	equal	**fare**	3.98	change
flower	4.50	summer	**flour**	4.39	baking
real	5.53	true	**reel**	3.56	fishing
rose	4.64	love	**rows**	3.77	columns
sweet	4.98	chocolate	**suite**	4.39	room
idol	3.44	hero	**idle**	3.40	lazy
great	6.00	extreme	**grate**	4.43	rub
sale	4.89	deal	**sail**	4.17	cruise
heal	3.75	wellbeing	**heel**	3.81	foot
won	5.36	competition	**one**	6.56	number
peace	4.74	harmony	**piece**	5.27	part
presents	4.20	gift	**presence**	4.34	being
knight	4.19	protector	**night**	5.65	evening
Mean	4.25		**Mean**	4.32	

Table 3: List of word stimuli for neutral/neutral homophones, along with respective word frequency

Homophone (positive)	Frequency	Associated word	Homophone (neutral)	Frequency	Associated word
allowed	4.98	granted	**aloud**	3.58	audible
bear	4.88	mammal	**bare**	4.04	naked
high	5.53	large	**hi**	5.28	greeting
male	4.66	gender	**mail**	4.63	post
meet	5.41	communicate	**meat**	4.80	poultry
new	5.98	novel	**knew**	5.36	certainty
eight	5.22	number	**ate**	4.20	food
plane	4.58	transport	**plain**	4.36	simple
poor	5.05	low	**pour**	4.25	flood
stare	3.76	gaze	**stair**	3.21	lift
pole	4.31	mast	**poll**	4.19	rankings
sent	5.02	email	**cent**	4.06	pence
I	7.33	individual	**eye**	5.13	anatomy
pause	3.86	moment	**paws**	3.61	feet
toe	4.08	foot	**tow**	3.57	machine
waste	4.72	rubbish	**waist**	3.71	middle
whether	5.39	choice	**weather**	5.12	climate
whole	5.54	together	**hole**	4.76	gap
jeans	3.84	denim	**genes**	3.78	biology
role	4.94	act	**roll**	4.86	bread
Mean	4.95		**Mean**	4.33	

Table 4: List of word stimuli for practice trials for neutral/neutral homophones, along with respective word frequency

Homophone	Word Frequency	Associated Word	Homophone	Word Frequency	Associated Word
time	6.35	clock	**thyme**	3.83	herb
past	5.30	history	**passed**	4.77	given
son	5.17	child	**sun**	5.01	warm
Mean	5.60		**Mean**	4.54	

The frequencies were obtained from a corpus of 201.3 million words from 45,099 BBC broadcasts and separate measures from CBBC and Cbeebies, using the Subtitle-based word frequencies for British English (SUBTLEX_UK), (Van Heuven, Mandera, Keuleers, & Brysbaert, 2014). Homophones across all groups were matched for word frequency (see *Table 5* for mean frequencies of experimental homophone groups), this was an important factor to control for. A two-way ANOVA was conducted to show that there was not a significant difference between the frequencies of each valence group, positive and negative. Results supported this requirement as no interaction was found [$F(1,28)=.533$, $p=.463$].

Table 5: Mean frequencies *(with SDs)* for negative/neutral, positive/neutral and neutral/neutral homophones

	Number of Homophones	Frequency of Valenced Meaning	Frequency of Neutral Meaning
Negative/Neutral	15	4.11 *(0.75)*	4.03 *(0.93)*
Positive/Neutral	15	4.75 *(0.78)*	4.25 *(0.96)*

For each homophone, there were two possible word associations presented visually on a computer screen. For example, for the homophone die/dye, one association was related to the emotional interpretation (e.g. funeral) and one was related to the neutral interpretation (e.g. hair). It must be noted that the associations related to the emotional interpretation were in some cases emotional themselves (e.g. funeral for die/dye), but not always (e.g. summer for flower/flour). The filler words also had two possible word associations, both neutral meanings. Word associations were determined through the use of http://www.thesaurus.com/. The top entry in the thesaurus was chosen as the word association for each target homophone. These associations were then piloted on a group of 10 students and necessary changes were made.

Procedure

The study was conducted by the researcher in a quiet room. The task was presented on the researcher's Windows Surface laptop using PsychoPy software (Peirce, 2007).

Upon arrival, potential participants were asked to read the participant information sheet and had the opportunity to ask questions. If they decided to take part in the study, they signed a consent form. The nature of the study meant that if participants knew its full aims, they might alter their responses. Thus, some information (i.e. that the study looked at the role of emotion/mood in determining the meaning of ambiguous words) was withheld from participants. As a result, participants were debriefed at the end of the study and given the opportunity to ask any questions.

The procedure lasted approximately 10 minutes and consisted of the following tasks:

Task 1 – Pre-Mood Measurement

Participants completed a mood measure which assessed their current state of feeling (Affect Grid, Russell et al., 1989). They then read the following instructions about how the Affect Grid was to be used: "An affect grid is used to describe feelings. It is in the form of a square grid - a kind of map for feelings. The centre of the grid marks a neutral, average, everyday feeling. The right half of the grid represents pleasant feelings, and the left half represents unpleasant feelings. The vertical dimension of the grid represents arousal." They were then asked to: "Fill out this grid, by placing the cross in one square, of your current feeling state." The participant then placed a single 'X' somewhere within the Affect Grid.

Task 2 – Mood Induction

After completion of the pre-task mood measure, participants were told that they would be shown some images, for approximately 1 minute, and that they were to look at these very carefully. Participants were randomly assigned into one of three mood induction groups: negative affect, positive affect and control group. All participants were shown 25 images. Each image was shown for 2 seconds, with a blank screen for 0.5 seconds between images.

Task 3 – Experimental Word Association Task

A word association task was then undertaken. Participants were asked to listen to a word (homophone) and then choose which out of the two presented words on the screen they most associated with the word they just heard. They were asked to look at both words but not to take too long as their response was timed. Responses were made via the left and right arrows on the computer keyboard and recorded with millisecond accuracy. Auditory stimuli were played through the computer's speakers at full volume.

There were 3 practice trials, all involving neutral/neutral homophones (e.g. time/thyme). This was then followed by 50 experimental trials. To maintain the induced mood in the negative affect and positive affect groups, valanced background tracks were played, a 'busy city' and 'birds tweeting' respectively. The participants in the control group did not hear any sound track. The soundtracks were played throughout the word association task at a low volume; the target homophone was presented above the level of the sound clip.

Task 4 – Post Mood Measurement

After completing the word association task, all participants completed another Affect Grid on their current state of feeling. This was to see whether the mood induction was maintained throughout the task. At the end of the study all participants were shown the images of smiling animals to counterbalance any short term negative effects induced by the experiment.

RESULTS

Mood Measurement

Mood measurement ratings (on energy and pleasure) were taken pre and post experiment using the Affect Grid (Russell et al., 1989). Each square in the Affect Grid corresponded to a rating, between -3 and 3. Mood group ratings were calculated by totaling the mood ratings, separately for energy and pleasure, and dividing them by the number of participants in each group (n=20). Mean ratings (with SDs) across the participant groups are presented in *Table 6. Table 6* shows that mood ratings given after the experiment were different to those given before. Statistical analyses were carried out to determine if there was a significant difference in the mood ratings pre and post experiment.

Table 6: Means *(with SDs)* of energy and pleasure ratings across mood induction groups during the experiment.

	Before Experiment	After Experiment
NEGATIVE MOOD GROUP		
Energy	-.35 *(1.66)*	-.25 *(1.68)*
Pleasure	.35 *(1.87)*	.70 *(1.42)*
POSITIVE MOOD GROUP		
Energy	-.75 *(1.62)*	-.35 *(1.69)*
Pleasure	1.25 *(1.41)*	1.95 *(1.00)*
CONTROL GROUP		
Energy	.40 *(1.54)*	-.50 *(1.76)*
Pleasure	1.15 *(1.39)*	1.50 *(1.32)*

A mixed-measures analysis of variance (ANOVA) was carried out on the pre-experiment ratings of energy and pleasure comparing the three mood induction groups. No significant difference was found between the groups at the outset of the experiment. A significant interaction was not found between the mood induction group and the pre-experiment mood ratings [$F(2,57)=1.921$, $p=.156$].

To evaluate the effectiveness of the mood induction procedures, a 3 x 2 x 2 mixed-measures ANOVA was conducted on the mood ratings with mood induction group (negative, positive, control) as the between-subjects factor, mood type (energy, pleasure) and mood rating time (pre, post) as within-subjects factors. Data was tested for homogeneity of variance by use of the Levene's test, no assumptions were violated, as $p>.05$. The ANOVA yielded a significant main effect of mood type [$F(1,57)=43.15$, $p<.001$] with pleasure being rated higher than energy but no other significant main effects or interactions were found.

Follow-up tests were undertaken and a paired-samples t-test indicated that, when comparing pre-experiment and post-experiment mood ratings, participants in the control group reported a significant change in their energy rating $t(19)=2.854$, $p=.010$. T-tests for the remainder of participants failed to reach significance for both their energy and pleasure ratings. Therefore, the mood ratings of participants in the experimental groups (positive mood groups and negative mood groups) failed to align with their induced mood. In addition, participants in the control group, who did not experience any mood induction procedure, only partially maintained their baseline mood rating. Their energy levels showed a significant decrease over the duration of the experiment, this could be due to a lack of interactive stimuli, in comparison to the experimental groups, leading to a more bored and tired mood state.

Homophone Word Association Task

The data for the homophone word association task was coded in the following way. For each word association, the response was given a '1' if it corresponded to the affect-related meaning of the homophone (e.g. die) and a '0' if it corresponded to the neutral meaning of the homophone (e.g. dye). Once aggregated across individual trials in each group, each participant's score reflected the proportion of responses in which they selected the affect-related meaning over the neutral meaning, multiplied by 100 to calculate percentages. Filler items (homophones and associated words that had neutral only meanings) were not analysed.

Data was tested for homogeneity of variance and normality by use of the Levene's test and the Shapiro Wilk test. The test statistics showed normally distributed data for the negative-affect related homophones in the positive and negative mood induction groups [$W(20)=.897$, $p=.036$ and $W(20)=.892$, $p=.029$ respectively]. Whereas, all other data did not show a normal distribution. Therefore, the assumption of normality required for the ANOVA was violated, but the homogeneity of variance was not, as $p>.05$. Despite this, it was considered appropriate to carry out a two-way ANOVA.

Participants responses were entered into a 3 X 2 mixed-measures ANOVA, with mood induction group (negative, positive, control) as the between-subjects factor and the within-subjects factor as the valence chosen within the homophone word association task (negative/neutral, positive/neutral). As predicted, a mood induction group and valence interaction was found to be significant [$F(2,57)=3.808$, $p=.028$], indicating that the valence of homophone choice varied as a result of the mood induction group. Significance for the main effect of valence was narrowly missed [$F(1,57)=3.943$, $p=.052$] but a main effect was found for the mood induction group, showing that the valence choice significantly varied within each group [$F(2,57)=5.061$, $p=.009$]. *Figure 2* shows the interaction between homophone valence choice across mood induction groups. A paired sample t-test was performed to test whether there was a significant difference between the groups. A significant difference of valence chosen was found for the positive mood induction group, positive participants were more likely to select positive-affect related meanings of a positive/neutral homophone, and the neutral meaning of a negative/neutral homophone [$t(19)=-2.871$, $p=.010$].

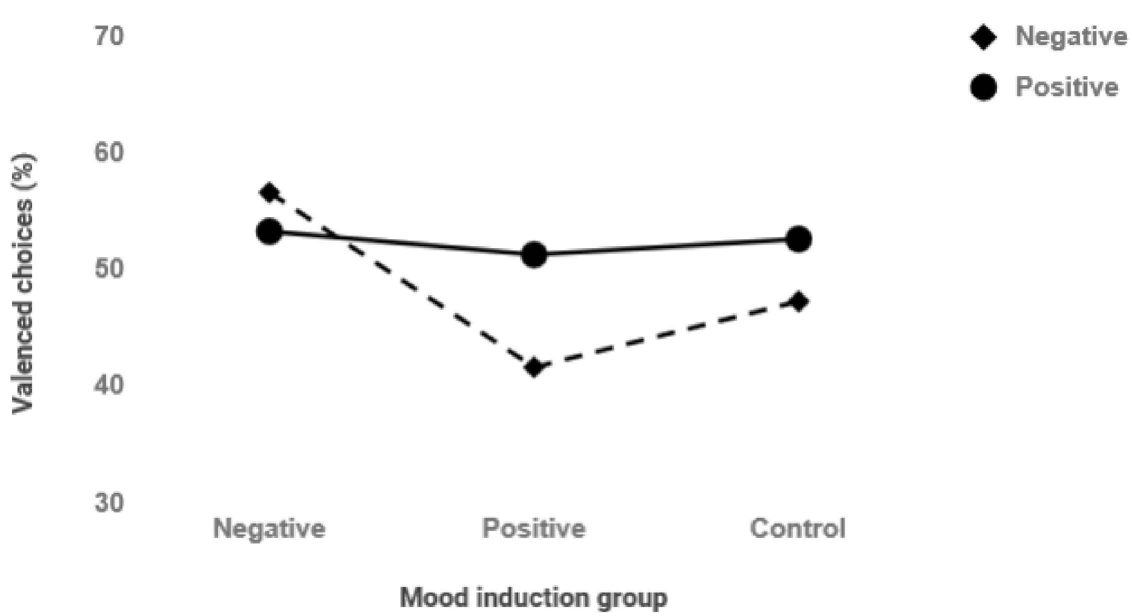

Figure 2: Interaction between homophone valence choice (%) for “negative” meaning (Negative/Neutral) and “positive” meaning (Positive/Neutral) across mood induction groups.

Reaction Times (RTs)

As an additional measure, RTs were gathered during data collation and statistical analyses are presented below in *Table 7.* In all mood induction groups, the RT for the positive meaning of a homophone was the fastest. In the significant mood induction group (positive), it can be seen that participants showed the slowest RT for the negative meaning of a homophone. A two-way mixed-measures ANOVA was performed on the RT data, mood induction group (negative, positive, control) was the between-subjects factor and the within-subjects factors were the valence chosen within the homophone word association task (negative/neutral, positive/neutral, neutral/neutral). A significant main effect was found for a difference in reaction times for each homophone valence [$F(2,56)=4.475$, $p=.019$], but no interaction between mood induction group and homophone type was found [$F(4,114)=.828$, $p=.510$]. Pairwise comparisons with a Bonferroni correction showed that the RTs of negative-affected related meanings of a homophones and positive-affect related meanings of a homophone were significantly different from each other, this was also found for positive-affect related homophones and neutral homophones. A paired samples t-test was then conducted to see if there was a significant difference between the mean RTs for each homophone valence across the mood induction groups. Significant differences were found in the control group for the negative and positive valence RTs and the negative and neutral valence RTs [$t(19)=2.589$, $p=.018$ and $t(19)=2.148$, $p=.045$]. No significant differences were found in the experimental groups, but significance for the positive mood group RTs of negative and positive valence, as well as neutral and positive valence were narrowly missed [$t(19)=2.047$, $p=.055$ and $t(19)=2.002$, $p=.060$ respectively]. These results will not be discussed in further detail as RT data was not within the purpose of the present study and only reported as such data is an additional tool of PsychoPy experiments (Pierce, 2007).

Table 7: Mean RTs *(with SDs)* of homophone valence for each mood induction group

Measure	Negative Mood Group	Positive Mood Group	Control Group
Negative Meaning	2.56 *(1.28)*	2.51 *(1.14)*	2.36 *(0.79)*
Positive Meaning	2.47 *(1.31)*	2.27 *(0.87)*	2.19 *(0.63)*
Neutral Meaning	2.68 *(1.80)*	2.43 *(1.27)*	2.25 *(0.72)*

DISCUSSION

In the present study, the aim was to investigate the effects of an induced mood on resolving lexical ambiguity in a word association task. It was predicted that an interaction would be found between the induced mood of the participant and the choice of homophone valence.

Previous studies have found emotion-congruent effects, but their results may be limited by the methodologies that were used such as the lack of a baseline condition/control group (of neutral words and no mood induction), the use of mood inducing music that differed in tempo and arousal and the restriction of effects to discrete emotions of happy and sad. This study attempted to address such issues. The between-subjects factor of mood group was induced by positive and negative images equated for intensity of arousal, which was determined by the researcher. A non-mood induction control group and ambiguous control word stimuli were also included.

The results found a main effect of mood type, with pleasure being rated higher than energy but no other significant main effects or interactions were found. Albeit not significant, the negative and positive mood groups showed improved global mood ratings post-experiment. This is an interesting trend for the negative mood induction group, as it was predicted that a negative induction would reduce one's mood rating. However, this increase is less than the global increase of the positive mood induction group. In contrast, the control group showed a significant reduction in only their energy mood rating post-experiment. This pattern of results is likely due to the higher levels of arousal produced by the stimuli of the positive and negative mood group in comparison to the control group which had no mood induction, and a less stimulating word association task as a consequence of no background sound, therefore an overall less interactive experiment in comparison to that of the experimental mood groups. Research by Sereno et al. (2015) supports this conclusion in reference to a lexical decision task. The experimental mood induction groups within this study had faster responses when selecting the word association in comparison to the control group. Similarly, to the present study, this was concluded as a consequence of higher levels of arousal produced by the mood induction (music), of which the control group received none.

Researchers have previously questioned whether a sufficient intensity of mood is induced or whether the effects witnessed are due to the demand characteristics of the individual. Thus, the effectiveness and validity of the mood induction measure (Affect Grid) and methods (images and background sound) in the present study shall be considered. In the 1980s, available scales of affect were multiple-item checklists or questionnaires that were time consuming. The Affect Grid (Russell et al., 1989) was developed as a single item scale that is short, easy to fill out, and simple to score. It has been shown to have strong evidence of validity and reliability in relation to group ratings of emotion-related words, group and individual ratings of facial expressions of emotion, as well as mood, through its comparison to Mehrabian and Russel's (1974) measure of pleasure and arousal. The Affect Grid has been used in multiple studies to test predictions about mood. Russell and Alden (1987) used the Affect Grid as a manipulation check in a mood induction study, supporting the use of the mood measure in the present study.

In contrast with the present study, research has shown that it is easier to experimentally manipulate a negative mood state than a positive one (Westermann et al., 1996; Uhrig et al., 2016). This non-significant induction of a positive mood was suggested to be a result of participants already being in a relatively positive mood, thus positive stimuli were simply 'absorbed' by the current mood, creating a ceiling effect. The negative stimuli contrasted with the baseline mood. This could be applied to the findings of the present study, as the experiment was conducted very close the exam and revision period – a key factor to consider in the student population. This could have led to an increased negative emotional state due to high stress levels exhibited during this sampling period. Thus, negative stimuli would have no significant effect on an already 'negative' population.

The use of mood maintenance background sound in studies conducted in this field has not, to my knowledge, been extensively explored. However, some research has shown supportive evidence for the use of natural and urban auditory stimulation on mood using implicit measures, such as skin conductance levels and heart rate variability (Alvarsson et al., 2010; Uhrig et al., 1991). The findings of the present study provide supporting evidence for the use of such auditory stimulation in experiments determined by explicit measures (e.g. Affect Grid and word association task). It can be concluded that such stimuli can be generalized across multiple contexts, including the influence of mood on resolving lexical ambiguity, as demonstrated by the present study.

An interaction was observed between the induced mood of the participant (negative, positive) and homophone valence chosen within the word association task (negative, positive), showing that the homophone valence choice varied significantly within each group. Thus, the prediction was supported. However, it was only significant for the positive mood group, who were more likely to choose positive affect-related meanings of a positive/neutral homophone, and the neutral meaning of a negative/neutral homophone. This indicated that the mood induction method for the positive mood group was sufficient enough to influence the choice of homophone selection. This differs from previous findings, which have found a negative state can influence the resolution of lexical ambiguity (Matthews et al., 1989; Halberstadt et al., 1995; Blanchette & Richards, 2003; Dearing & Gotlib, 2008; Gordon et al., 2016). No significant relationship was found between the negative mood group and their choice of homophone valence. Results showed that they chose the negative meaning of a negative/neutral homophone more, which is aligned with the prediction of the current study.

It has been proposed in various models of emotion word processing (Bower, 1981; 1987; 1991; Taylor, 1991; Pratto & John, 1991) that all emotionally valenced words experience an initial facilitation relative to neutral words because of their high arousal, but that negative words are then inhibited due to their low valence and, thus, inherent threat. This would predict a consistent advantage in processing for positive over neutral words and an advantage for negative over neutral words under some circumstances. It should be considered that the mood induction and maintenance used in the present study was relatively mild in comparison to other studies, due to ethical restrictions on UG projects, and may not have been enough to induce a sufficient negative mood. Studies inducing emotions through using a dummy camera (Blanchette & Rose, 2003) or autobiographical recall (Gordon et al., 2016), allow more flexibility in the intensity of the induced mood. From the statistical analyses conducted, this surprising divergence from previous research was found not to be because of differences in mood ratings between groups at the outset of the experiment.

Although an interaction was seen between mood induction group and homophone valence, the mood induction group did not completely constrain the participant's selection of word meanings. Participants still provided neutral choices in the word association task, suggesting that emotion may be one of many possible constraints on lexical selection i.e. the frequency of a word, although this was controlled for in the present study. The finding that emotion did not completely constrain the homophone valence choice shows that participants must have had lexical access to the neutral meaning as well as the affect-related meaning. This provides support for the multiple-access model. Further research could be conducted on this result using CMPTs (Swinney, 1979), to determine at what stage emotion has an effect on lexical access.

The issue of a lack of disparity between the meanings of the positive/neutral homophones in the present study should also be noted. The 'positive' meaning wasn't seen as significantly distinct from the 'neutral' meaning, this was found across all mood induction groups. Those in the experimental mood induction groups showed a significant difference between their choice of meaning in negative/neutral homophones, this can be concluded as a result of a sufficient distinction between the 'negative' meaning and the 'neutral' meaning of the ambiguous word. This asymmetry was also found by Halberstadt et al. (1995), a spelling task was utilised to look at the role of mood/emotion on lexical ambiguity. It was found that "sad" participants were more likely to write down the sad spelling of a word than "happy" participants. This emotion-congruence effect (Bower, 1981; 1987; 1991) was not supported by the transcription of happy subjects. A possible influence of this asymmetry may lie in the influences of affect on categorisation. For example, this can be seen in the above study and the present study, the 'happy/positive' subjects may not see 'neutral' meanings as neutral, but temporarily positive. Potentially accessing 'bridal' (positive) and 'bridle' (neutral) equally often as wedding are generally seen as positive and horse-riding could a hobby. Some support has been found for this interpretation of a greater distinction between negative/neutral categories, than positive/neutral (Isen, Johnson, Mertz, & Robinson, 1985; Isen, Niedenthal, & Cantor, 1992).

While the findings of the present study extend the current literature and suggest that mood constrains the resolution of lexical ambiguity, there are limitations. Participants of the present study may have been sensitive to the demand characteristics of the experiment due to its multiple stages: mood rating, mood induction procedure and word association task. They may have recognised that target words had alternative meanings, some corresponding to the type of images seen in the mood induction procedure, thus altering their results accordingly. This cannot be verified as participants did not have the opportunity to disclose whether they noticed affect-related target words. Given the prevalence of neutral meanings chosen during the homophone word association task, it seemed likely that performance on the homophone word association task reflected a real influence of mood induction group on the lexical selection procedure. A more favourable outcome could potentially be achieved through more participants, a small sample size limits the study's generalizability. As discussed, the sampling period may have influenced individuals' responses due to higher stress levels around exam/revision period.

Further limitations include the use of mutually exclusive sound clips to maintain the induced mood. This is not a 'real-world' influence, external sound environments are commonly a mix of many sounds, ranging from nature to traffic noise. The findings as a result of this mood induction method must be generalised with caution. Further research could use stimuli from a standardized database of sounds, such as the International Affective Digitised Sounds (IADS) which is the main source of sounds used in emotional acoustic research with ecological stimuli (Bradley & Lang, 1999). All mood induction stimuli were determined by the researcher, therefore subject to bias. Similarly, with the IADS, the IAPS (Lang et al., 2005) provides a set of standardised images that are typically shown for 6 seconds, the present study showed images for 2 seconds with an intermittent white screen for 0.5 seconds. The relevance of linguistic properties such as the positive vocal affect of a female voice should be considered (Nygaard & Lunders, 2002), especially since an interaction with homophone valence was only seen in the positive mood group. It is likely that some of above factors may have influenced the findings.

Current research is typically based samples of healthy individuals, but some work has been conducted on clinical populations (Eysenck et al., 1991; Matthews et al., 1989). No research to date has examined negative bias for healthy individuals at risk of depression, only clinically depressed adults, on their interpretation of ambiguous stimuli. The work of Dearing and Gotlib (2008) is the first demonstration of such a case and a pioneering study in children as prior research has been exclusively conducted on students. Emotion-congruent effects were seen, this provides implications for real life applications. Future research should look to identify vulnerability factors, as characterized by specific cognitive biases, as they demonstrate a notable influence on how one resolves lexical ambiguity. This is especially key in student populations as there is a 33.7%-point prevalence of clinical disorders in the female 18-25 age group alone (Vázquez, Torres, Otero & Díaz, 2011). This fact questions whether the results of previous studies (Matthews et al., 1989; Halberstadt et al., 1995; Blanchette & Richards, 2003, & Gordon et al., 2016) stating that an interaction was found between a negative mood induction and choice of homophone valence is valid. It may be due to the prevalence of clinical disorders in the samples studied, which could be a factor for later research. Personality traits could also be considered. Gordon et al. (2016) was the first to use a combination of personality characteristics to understand dispositional influences on the interpretation of ambiguous stimuli in an affect-related context. It is often assumed that an overall negative mood has an influence on the increased negative interpretation of an ambiguous scenario. Personality characteristics were not considered in the present study, but such data would allow further conclusions to be made regarding the influence of emotion/mood on the resolution of lexical ambiguity.

In this study the aim was to investigate the effects of an induced mood on a central cognitive process: the resolution of lexical ambiguity, notably by employing fixed experimental controls over both the mood induction procedure, mood maintenance and word stimuli. Previous studies have found emotion-congruent effects but typically for discrete emotions of ‘happy’, ‘sad’ and ‘angry’. This study attempted to extend these findings to more general categories, such as ‘positive’ and ‘negative’. The present study is important in demonstrating patterns of mood on resolving lexical ambiguity in a novel manner, but only for the positive mood group. An interaction was found between the positive mood induction group and the homophone valence choice. The role of mood on resolving lexical ambiguity should utilize implicit measures, such skin conductance levels, in addition to explicit measures of mood such as self-report data, to provide additional value. The present study adds to the growing body of work showing that mood can have an important effect in resolving lexical ambiguity by providing up-to-date evidence of novel measures and methods to investigate such an area.

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