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Investigating Image-based Context Effects on Memory and False Memory.

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Abstract

The present study aims to explore how image-based contexts affect memory, false memory and associative false memory. Fifty-six participants, aged between 18-65 years old, took part in all conditions of the experiment and were obtained through an opportunity snowball sampling method. The study contained two independent variables: Context and Backward Associative Strength (BAS), creating a two (Background type condition; Same vs. Different background types) within-subjects by two (Backward associative strength list condition; Low vs High Backward Associative Strength) within-subjects ANOVA. The study measured the number of correct, non-critical false and false critical recall responses after each DRM list presentation. Analysis of data showed that there was a significant interaction between context and BAS for correct recall. Results also found significant main effects of context and BAS for false critical recall but failed to produce a significant interaction. No significant main effects were found for context or BAS on non-critical false recall. Although the current study cannot directly make an impact in the real world (Pardilla-Delgado et al, 2017), context dependent memory research does associate with a broad spectrum of applications including: Eye witness testimony, cognitive interview, educational purposes, and potentially aid the development of environmental reminiscence therapies.

KEY TERMS:	CONTEXT DEPENDENT MEMORY (CDM)	BACKWARD ASSOCIATIVE STRENGTH (BAS)	NON-CRITICAL FALSE MEMORY	FALSE CRITICAL MEMORY	DRM PARADIGM

Introduction

Extensive psychological research has been conducted on exploring the phenomena of memory, however, more recently research has focused on understanding human cognitive error, otherwise referred to as, false memory (Hicks and Hancock, 2002; Laney and Loftus, 2013). Memory can be described as ‘a reconstruction of the past’ (Beato and Arndt, 2017:358) and is a highly complex cognitive concept that may be expressed in many different forms (Cowan, 2008). Generally, early cognitive models separate memory into short-term and long-term stores (Atkinson and Shiffrin, 1968; Craik and Lockhart, 1972; Baddeley and Hitch, 1974), differing in their fundamental functioning, capacity, storage and encoding processes (Norris, 2017). It has been well established that memory cannot be confined to a simple unitary system (Sherry and Schacter, 1987) and although our knowledge on memory has significantly progressed over time, there is still much to be learned. Thus, memory research remains a continuing area of psychological interest (Schachter, 2013).

Human memory is highly susceptible to distortion and error (Schacter et al., 2011; Marini et al., 2012; Beato and Arndt, 2017), manipulated by both internal (for instance, emotions) and external (for instance, physical location) contexts. One’s physical environment can often be distracting (Craik, 2014; Rae and Perfect, 2014) thus, an established area of memory research has concentrated on observing how context may influence human memory. Environmental context effects refer specifically to ‘incidental information about the environment in which the focal information is processed’ (Isarida and Isarida, 2007:1620). Influential research on context effects using physical locations stem from Godden and Baddeley (1975), who directed divers to encode lists of words either on land or underwater. Their findings illustrated that reinstating the same physical location during encoding and retrieval significantly enhanced recall, whereas changing physical locations impaired recall (Godden and Baddeley, 1975). Similarly, Smith et al. (1978) supports the notion that context reinstatement increases the ability to remember, as they discovered that the percentage of words participants recalled in matching locations was considerably higher than in mismatching locations. Thus, the type of memory elicited during such experiments is commonly known as ‘context dependent memory’ (CDM), as CDM properties may be activated by appropriate environmental contexts related to target memories or experiences (Barsalou, 1982; Smith and Vela, 2001). Therefore, traditional context effect research has portrayed that maintaining the original context during both encoding and retrieval may lead to optimal memory performances (Smith and Vela, 2001; Hockley, 2008).

Later research has explored whether the same reinstatement effect is evident in more subtle contexts. For instance, Pointer and Bond (1998) utilized an olfactory stimulus to employ CDM, confirming that odour reinstatement resulted in significantly greater recall, emphasizing odours as a key context-dependent sensory cue. Further support from Parker et al. (2001), established that changing the odour (lemon and lavender) during encoding and then recall four weeks later, was sufficient to impair participants’ ability to remember lists of words. However, controversial studies have failed to attain the same effects (Bjork and Richardson- Klavehn, 1989), as research infers that different individuals’ perceptions of certain odours concerning their distinctiveness and appropriateness might influence the processing of memory (Herz, 1997; Ball et al., 2010), subsequently creating slight inconsistencies with odour context findings.

In addition, a multitude of research has investigated the influence of background noise or music as an auditory context on memory (Blach and Lewis, 1996). For example, Smith (1985) demonstrated when the same background sound was presented during encoding and test, participants displayed significantly higher recall at retrieval compared to those who experienced different background noises or no sound at all. Supporting evidence derives from Mead and Ball (2007), who revealed that remembering newly learned information enhanced when the same music was reinstated during learning and subsequent testing. Nevertheless, auditory context research could be criticised due to its associations with mood (Blach and Lewis, 1996). For instance, findings propose that the tempo of music can influence the stimulation of arousal, and therefore, an increased memory recall may be due to the recreation of mood dimensions, rather than music alone (Mead and Ball, 2007).

In contrast to external contexts such as physical location, odour and music; research has also considered affective and physiological context effects on memory. For example, previous findings suggest that when the same mood is induced during learning and retrieval, recall and recognition rates are superior to experiencing different moods (Eich and Metcalfe, 1989; Robinson and Rollings, 2010). Eich (1980) further discussed how subjects who changed their pharmacological state between study and test resulted in impaired retrieval of information, highlighting how changing a person's biological 'environment' using drugs or alcohol can too influence memory recollections. Moreover, Thompson et al. (2001) suggested that physiological responses such as increased cortisol, associated with arousal or stress, could affect memory. Their study indicated that when participants experienced reinstated 'low stress' conditions (such as, watching a sky dive), memory recall significantly increased. However, it is important to highlight that reinstatement of highly stressful contexts can in fact stop the encoding of information entirely (Thompson et al., 2001). Despite the ethical controversies regarding the applications of physiological context effect research, such as encouraging stressful contexts in police interviews, as discussed by Robinson and Rollings (2010), a majority of research emphasises the significance of context reinstatement for increasing human memory recall.

Within the past few decades, psychologists have particularly expressed an interest in studying the imperfect processes involved in memory (Schacter et al., 2011; Bookbinder and Brainerd, 2016). These 'imperfect processes' refer to false memory, which can be defined as 'situations in which subjects recollect events that, in fact, they did not experience' (Bookbinder and Brainerd, 2016:1316). One of the most widely used methods for studying associative false memory however, is known as the Deese-Roediger McDermott paradigm (DRM) (Deese, 1959; Roediger and McDermott, 1995; Roediger et al., 2001). Essentially, the DRM paradigm includes lists of words that all semantically relate to one single, non-presented critical lure word (Knott et al., 2012; Beato and Arndt, 2017). Researchers practicing this method typically will ask participants to learn a list of words, then later, either write down or verbally recall words in any order (Woods and Dewhurst, 2018).

DRM lists tend to be ranked based upon their Backward Associative Strength (BAS). BAS has been recognised as a robust predictor of associative false memory within the DRM paradigm (Huff and Hutchinson, 2011), and specifically refers to 'a measure of association between studied lists of words and falsely recalled non-presented critical words' (Cann et al., 2011:1515). Often, findings have indicated that participants falsely recognise and recall unstudied critical words in DRM lists (Cann et al, 2011; Arndt, 2015; Coane et al., 2016; Cadavid and Beato, 2016). This phenomenon may be explained by BAS, as research highlights that 'high' BAS lists lead to greater false recognition and recall compared to 'low' BAS lists (Cann et al, 2011; Knott et al., 2012; Beato and Arndt, 2017). Although, the DRM is primarily designed to trigger the production of false critical lures (Hancock et al., 2003), Dewhurst et al. (2009) proposes that correct recall may also be influenced, finding that correct recall increased in high BAS list conditions. In addition, Huff and Hutchinson (2011) discuss that there is little knowledge on false memories that indirectly relate to non-presented critical lures, and so, research may need to address this area to gain a better understanding about the full potential of the DRM paradigm on not only false critical memory, but also non-critical false memory. Although the DRM paradigm is accepted as a relatively strong phenomenon for associative false memory in both adults and children, the underlying mechanisms of the variable are less understood (Howe et al., 2009; Cann et al., 2011).

Interestingly, contemporary research studying the effects of context on false memories is relatively sparse (Woods and Dewhurst, 2018). Cann and Ross (1989) investigated false memory using odours as the context dependent cue, finding participants' recognition performance on depicting faces was more accurate in odour context reinstatement. Thus, participants produced higher correct memories and lower false memories (Cann and Ross, 1989). Consistent findings developed from Woods and Dewhurst (2018), who further emphasised that correct recall enhanced with odour reinstatement, whereas false critical memories reduced. Moreover, Brown (2003) discussed context reinstatement concerning eyewitness testimony applications using line up photographs. Brown (2003) found that correct memory recognition was considerably greater when context was reinstated, whilst false alarms significantly decreased. Furthermore, Goodwin (2013) discussed that context reinstatement appears to have a beneficial influence on reducing false memories whilst improving correct memory accuracy but noted that verbalisations of false critical memory instances significantly increased, especially when original information was encoded in an elaborative manner (Goodwin, 2013).

However, Tamminen and Mebude's (2018) study did not conform to such findings, as they found that odour reinstatement did not display any significant effect on false memory recall production. According to research, the existence or absence of significant context effects on memory or false memory may occur depending on the strength of contextual and item cues (Mahbub, 2015; Woods and Dewhurst, 2018). Therefore, when item associative cues, such as DRM lists, are paired with context presentations during encoding processes, DRM material may 'overshadow' (Isarida et al., 2012) contextual cues, and so, could suppress context effects (Isarida et al., 2012). On the other hand, the outshining principle (Smith, 1988; Mahbub, 2015) suggests that at retrieval, the strongest cue may weaken the other. For example, item associative cues tend to 'outshine' contextual cues at retrieval, meaning context may not be able to trigger target items as effectively (Isarida et al., 2012).

Aside from odour context, research proposes that remembering verbal information may improve when associated with visual material (Lynn et al., 1985). Therefore, psychologists have been intrigued to assess how visual-based contexts, such as, background colour (Pointer and Bond, 1998; Isarida and Isarida, 2007), background photographs (Gruppuso et al., 2007; Isarida et al., 2018) and video stimuli (Smith and Manzano, 2010, Smith et al., 2014) may influence memory recall. Although, a majority of research on reinstating background colour has proved to be non-significant on correct memory recollection (Pointer and Bond, 1998; Isardia and Isardia, 2007), Watkins and Watkins (1975) provide a plausible explanation, as they suggest that presenting one common background colour throughout encoding may lead to a cue 'overload' and as a result, eliminate CDM. The cue overload principle claims that one background colour throughout study and test cannot be strong enough to produce similar context effects like odour or place. Thus, it could be argued that semantically rich visual contexts, such as photographs, may offer a stronger context effect on memory compared to that of background colour (Sakai et al., 2010). For instance, Isarida et al. (2018) superimposed unrelated words on 'sensible' and 'insensible' background photographs. Their results demonstrated that context-dependent recognition occurred with sensible photographs but not insensible ones, establishing that recall in the same context was significantly higher than in different contexts. However, it is important to note that there was no significant effect observed on false alarm rates (Isarida et al., 2018). Although, this research supports the idea that reinstatement of context aids memory recall, this effect may have been witnessed due to easiness of viewing pictorial integration, for instance the 'sensibleness' of the photograph itself may have had a greater effect than the reinstatement of the photograph (Isarida et al., 2018).

It is evident that research regarding image-based context effects on memory is limited, and even more so on false memory (Huffs and Hutchinson, 2011; Woods and Dewhurst, 2018). However, general context effect research has proved to be an important area of psychological study due to its broad spectrum of applications in the real world (Bookbinder and Brainerd, 2016). Therefore, the present study aims to advance our current knowledge on image-based contexts as well as BAS to examine their effects on correct memory, non-critical false memory and false critical memory recall. In order to do this, the study will investigate whether presenting same and different images during encoding and retrieval processes will influence memory recall. The study also aims to explore the role of high and low BAS on memory recall by using the DRM paradigm (Roediger et al., 2001) and potentially observe how the two variables may interact. As image-based contexts and BAS are a rare combination of variables in memory and particularly false memory research, the current study intends to address the 'gap' in research within this field.

Hypotheses

Considering the findings illustrated in previous research, the current study hypothesized that:

Correct Recall

- Correct recall in reinstated same contexts will be significantly greater compared to that of different contexts.
- There will be a significant interaction between context and BAS on correct recall.

Non-critical False Recall

- Non-critical false recall will be significantly lower in reinstated same contexts compared to that of different contexts.
- High BAS will significantly increase non-critical false recall compared to low BAS.

False Critical Recall

- False critical recall will be significantly lower in reinstated same contexts compared to that of different contexts.
- High BAS will significantly increase false critical recall compared to low BAS.
- There will be a significant interaction between context and BAS on false critical recall.

Methodology

Design

The present experiment included two independent variables and created a two (Background type condition; Same vs. Different background types) within-subjects by two (Backward associative strength list condition; Low vs High Backward Associative Strength) within-subjects ANOVA. Dependent variables measured correct free recall of studied words, false free recall of unstudied words, and false free recall of unstudied critical lure words.

Participants

Overall, 56 participants aged between 18-65 years old were obtained through opportunity snowball sampling, whereby 22 males and 34 females participated. The sample size was adjusted to 56 participants as it calculated to show an 80% power level, which is known as an ‘ideal power’ for any psychological study (Wittes, 2002; Kadam and Bhalerao, 2010; Suresh and Chandrashekara, 2012). Participants were involved in all conditions of the experiment due to the repeated measures design. A social media advert (See APPX. A) was created to recruit a wider range of voluntary participants.

Materials, Apparatus and Measures

The current study used ‘Microsoft Power Point’ as the primary material, consisting of 157 slides in total, including 18 different background images, 120 audio-recorded words and 24 slides containing written instructions (See APPX. B). Audio-recordings were created using a microphone and inserted into the necessary slides. All audio recordings were presented for 2 seconds and half of a second was left between each, using the timer provided on Microsoft Power Point, similar to Goodwin’s (2013) procedural technique. Audio representations of DRM lists were used in attempt to avoid ‘insensible’ pictorial integration as discussed by Isarida et al. (2018). A mathematical interval task was timed for 30 seconds in-between encoding and retrieval stages, consistent with previous studies in the field (Isarida and Isarida, 2007).

The present experiment adopted the work of Konkle et al. (2010), who has provided a statement of ‘free use’ for further psychological research. Based upon the researcher’s judgement, 18 ‘neutral’ scenic images were selected from Konkle et al. (2010) in attempt to avoid evoking any emotional response that may distract participant focus (Wiswede et al., 2006). All images were individually inserted into the slides as ‘backgrounds’ in order that image-based context effects could be generated (See APPX. C).

Deese Roediger-McDermott (DRM) lists of words were developed from the work of Roediger et al. (2001). The researcher selected 12 lists from Roediger et al. (2001) 55 DRM lists depending on the Backward Associative Strength (BAS) that each list possessed. Five words were removed from each list to allow the creation of lower and higher BAS scores, as well as avoid a potential ‘cue overload’ (Watkins and Watkins, 1975; Isarida and Isarida, 2007). Therefore, participants were presented with 12 DRM lists of 10 words each, 6 of which were high BAS and 6 low BAS. Five separate versions of the experiment were developed by placing multiple combinations of ‘type of list’ and ‘background type’ into different orders (See APPX. D) to reduce the likelihood of primacy and recency effects as well as counterbalance the data set (Brooks, 2012).

Experiment booklets were prepared including ethical documents such as: a participant information sheet, consent form, written debrief, personal Id code and a small demographic questionnaire regarding participants gender and age (See APPX E., Pages:40-47). A further twelve tables were added so that ‘recall’ data could be recorded by the researcher (See APPX E., Page:44). All ethical procedures followed Manchester Metropolitan University’s ethical framework and the present study received ethical approval (See APPX. F).

Procedure

Participants were invited to meet the researcher in either a university study building or quiet place where both the participant and researcher felt comfortable. There was an intentional effort made to ensure that the experimental environment in which the participant and researcher were situated in was similar to maintain consistency and avoid potential confounding variables (Pourhoseingholi et al., 2012). Each participant was provided with the ethics booklet, asked to read the information provided, and then directed to fill in the relevant sections. Personal identity codes were created to ensure participants remained anonymous throughout the study and the right to withdraw was explained. All raw data was stored on encrypted computer software and remained confidential. Once participants consented to take part, experiment booklets were returned to the researcher. Copies of appropriate ethical documents were provided for participants to keep if they wished.

Participants were randomly allocated to one of the five versions of the experiment and all tested individually under controlled conditions. Prior to the experiment, participants could ask any questions they had regarding the research project. Participants were then informed that they would need to listen to information through a set of headphones and follow the instructions presented on screen. The researcher instructed participants to try and look at a computer monitor throughout the entirety of the task, then click on the screen when ready to begin the experiment. Power point slides were designed with a background image and simultaneously different oral words were presented through the headphones.

Similar to previous research, participants were instructed to ‘count backwards from (a number) in 3’s aloud’ for 30 seconds after each list presentation as a filled retention interval (see Isarida and Isarida, 2007). Participants were asked to orally recall words in any order from the list. The researcher would write participants recalled words in the experiment booklet tables. Recall stages were not timed, however, recall did not exceed over 5 minutes. The above procedure was repeated for all 12 DRM lists. However, the experiment was divided into four different conditions: low BAS words with same context, high BAS words with different contexts, low BAS with different contexts and finally high BAS words with same context. Thus, some lists were encoded and recalled using the same background image, whereas others were encoded and recalled using different background images.

Participants were debriefed after the experiment and asked to provide an email address if they wished to be sent further information regarding the study. Researcher contact details were provided to participants for any concerns or queries. The data collected from the experiment was inputted into the computer-based software: SPSS V. 25.0 (See APPX G., See Pages: 53-56) and then analysed.

Results
Correct Recall
Analysis

The following data was analysed using a 2 (Backward Associative Strength Score; High vs. Low) within-subjects x 2 (Context; Same vs. Different) within-subjects ANOVA.

Table 1

Mean (M) and Standard Deviations (SD) of Context Effects vs. BAS Scores on Correct Memory Recall

	BAS			
	High		Low	
	M	SD	M	SD
	(n = 56)		(n = 56)	
Context				
Same	19.93	3.29	16.23	3.54
Different	19.32	3.25	17.80	4.26
Overall	19.63	3.27	17.02	3.90

Table 1 demonstrates that there was a significant main effect of BAS score, $F(1, 55) = 34.84$, $p < .001$, η_p^2 .388, showing that high BAS increased memory recall in comparison to low BAS. However, the main effect of Context was not significant, $F(1, 55) = 3.22$, $p = .078$, η_p^2 .055. The interaction however, was significant, $F(1, 55) = 14.16$, $p < .001$, η_p^2 .205 (see Figure 1).

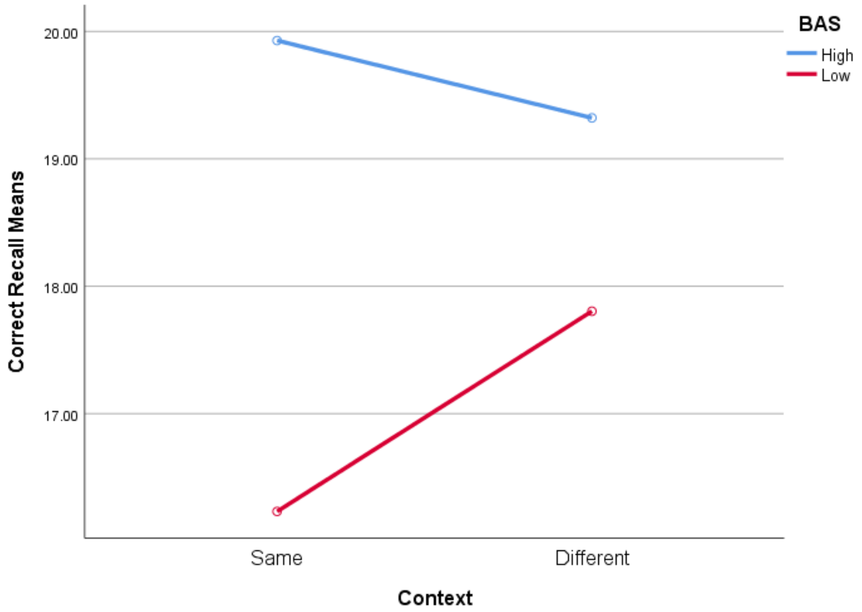

Figure 1. Correct recall as a function of context (same vs different) and BAS (low vs high).

The data above shows that there was a significant interaction found between Context and BAS scores, however, ANOVA alone cannot identify where the significant difference lies between the two study variables. Therefore, once parametric assumptions were met, two post hoc repeated measures t-test was conducted to interpret the significant interaction (Dancey and Reidy, 2017).

In order to decrease the risk of type 1 errors occurring within the data set, a Bonferroni correction alpha was applied of .025 (0.05/2) (Armstrong, 2014; Ranganathan et al., 2016). Therefore, 0.025 (2.5%) becomes the new value of significance to interpret the significant interaction from (Dancey and Reidy, 2017).

The first t-test demonstrated a significant difference in correct recall between High BAS and Low BAS when the same context was presented, $t(55) = 7.97$, $p < .001$, d= 1.08, 95% CI [2.77- 4.63], showing a large effect size according to Cohen's conventions (Cohen, 1988). The second t-test found a significant difference in correct recall between High and Low BAS when different contexts were presented, $t(55) = 2.69$, $p = .012$, d= .040, 95% CI [0.34-2.69], which according to Cohen represents a small effect size (Cohen, 1988).

Non-Critical False Recall

These data were analysed using a 2 (BAS; High vs. Low) within-subjects x 2 (Context; Same vs. Different) within-subjects ANOVA.

Table 2

Mean (M) and Standard Deviations (SD) of Context vs. BAS Scores for False recollections

	BAS			
	High		Low	
	M	SD	M	SD
	($n = 56$)		($n = 56$)	
Context				
Same	2.33	1.85	1.95	1.74
Different	2.21	1.67	2.13	1.38
Overall	2.27	1.76	2.04	1.56

Table 2 highlights that there was no significant main effect of BAS score, $F(1, 55) = 1.189$, $p = .280$, η_p^2 .021. The main effect of Context was also not significant, $F(1, 55) = .023$, $p = .880$, $\eta_p^2 < .001$. There was no significant interaction, $F(1, 55) = .693$, $p = .409$, η_p^2 .012. (see Figure 2).

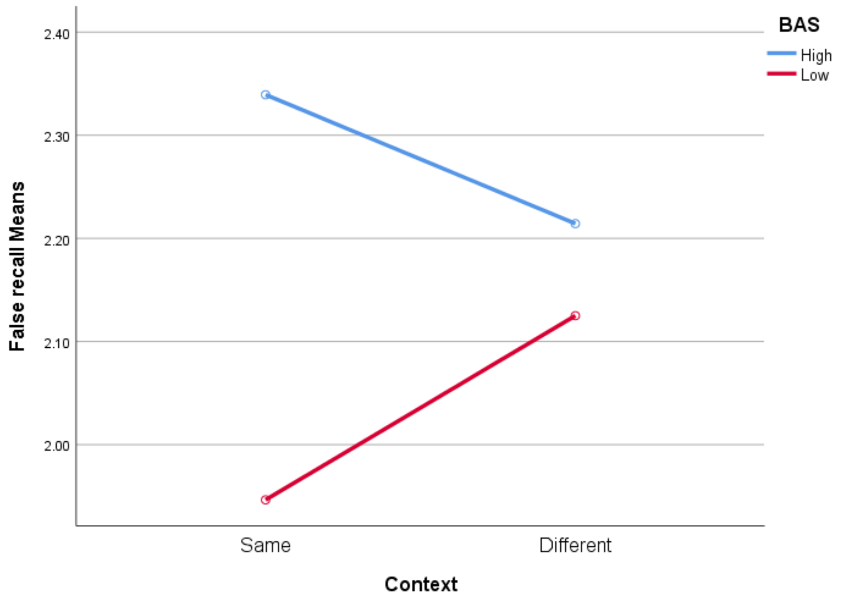

Figure 2. Non-critical false memory as a function of context (same vs different) and BAS (high vs low).

False Critical Recall

The following data was analysed using a 2 (BAS; High vs. Low) within-subjects x 2 (Context; Same vs. Different) within-subjects ANOVA.

Table 3

Mean (M) and Standard Deviations (SD) for Context vs. BAS for False Critical Recall

	BAS			
	High		Low	
	M	SD	M	SD
	(*n* = 56)		(*n* = 56)	
Context				
Same	2.04	0.93	0.25	0.51
Different	1.77	0.83	0.14	0.35
Overall	1.91	0.88	0.39	0.43

Table 3 shows that there was a significant main effect of BAS score, $F(1, 55) = 280.898$, $p < .001$, η_p^2 .836. The main effect of Context was also significant, $F(1, 55) = 4.971$, $p = .030$, η_p^2 .083. The interaction was not significant, $F(1, 55) = 1.082$, $p =.303$, η_p^2 . 019 (see Figure 3).

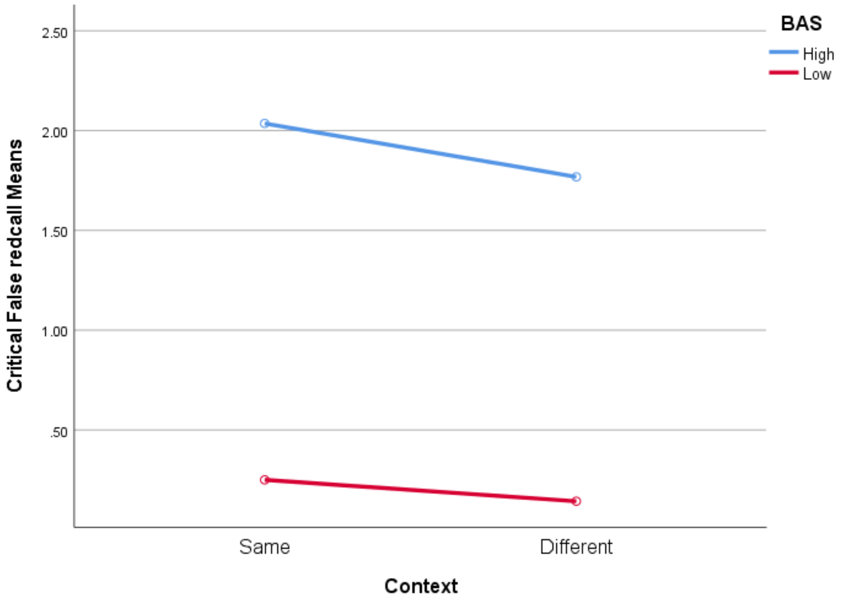

Figure 3. False critical memory as a function of context (same vs different) and BAS (high vs low).

Discussion

The present experiment aimed to explore image-based context effects on memory, false memory and associative false memory. This was achieved by exposing 56 participants to same or different images (Konkle et al., 2010) during encoding and retrieval whilst simultaneously combining each image with oral representations of DRM lists (Roediger et al., 2001), either categorised into 'high' or 'low' BAS. Subsequently, correct recall of studied words, non-critical false recall of unstudied words and false critical recall of unstudied 'lure' words were each measured individually.

Considering previous literature, it was hypothesized that reinstatement of the same context at encoding and retrieval would significantly increase memory recollection compared to different contexts (Godden and Baddeley, 1975; Smith et al., 1978; Pointer and Bond, 1998; Parker et al., 2001; Hockley, 2008; Woods and Dewhurst, 2018; Isarida et al., 2018). However, the current findings illustrated that there was no significant main effect of context found for correct memory recall, and so, rejects the first study hypothesis. Nevertheless, results did confirm a significant interaction between context and BAS for correct recall, thus accepting the second study hypothesis. Consequently, post hoc repeated measures T-tests showed significant differences between low and high BAS for same contexts, as well as different contexts. Therefore, results indicate that reinstatement of the same context significantly enhanced correct recall for high BAS lists than different contexts, and conversely, different contexts significantly increased correct recall for low BAS lists than the same contexts.

Further reflection upon prior research meant the study proposed that reinstatement of the same context would significantly reduce non-critical false recall (Cann and Ross, 1989; Brown, 2003; Goodwin, 2013). However, as no significant difference was found between same and different contexts in non-critical false recall, the null hypothesis was accepted. Though there is very little known about the effect of BAS on non-critical false memory (Huff and Hutchinson, 2011), it was hypothesized that high BAS would significantly increase non-critical false recall compared to low BAS, expecting to produce a similar effect to that of false critical memory (Cann et al., 2011; Knott et al., 2012; Arndt, 2015; Beato and Arndt, 2017). However, there was no significant difference found between high and low BAS for non-critical false recall and therefore, accepts the null hypothesis.

Based upon previous evidence, this study hypothesized that false critical recall would significantly reduce when same contexts were reinstated compared to different contexts (Woods and Dewhurst, 2018). The current results however discovered the opposite effect. Even though a significant main effect was displayed, the results indicated that false critical recall was in fact greater in same contexts compared to different contexts. Therefore, these findings reject the study hypothesis, but do support empirical works by Goodwin (2013), who also discovered that when contexts are reinstated, verbalisations of critical lure words were much greater. It was also hypothesised that false critical recall would significantly increase in high BAS compared to low BAS. Findings indicated that there was a significant main effect of BAS on false critical lure responses and so, this hypothesis was accepted, supporting a multitude of previous psychological research (Cann et al., 2011; Knott et al., 2012; Arndt, 2015; Cadavid and Beato, 2016; Beato and Arndt, 2017). However, there was no significant interaction found between context and BAS for false critical recall.

Overall, the current findings are somewhat congruent with the concept that reinstating visual-based contexts during encoding and retrieval processes have the potential to increase CDM (Smith and Manzano, 2010; Smith et al, 2014; Isarida and Isarida, 2018). In the present study however, the CDM effect observed in previous work was only evident in high BAS list conditions. This may be explained by a robust effect of context reinstatement combined with high BAS to enhance memory recall (Dewhurst, 2009; Isarida and Isardia, 2018). On the contrary, the fact that different contexts produced significantly greater correct recall for low BAS words appears to be an anomaly. It could be argued that in some instances, changing visual context stimuli (such as background colour) at encoding and retrieval is enough to provide a context effect itself and subsequently produce more precise recall (Isarida and Isardia, 2007). Whereas, having one common visual context presented throughout encoding and test may lead to a cue overload (Watkins and Watkins, 1975). However, if this were to be accurate in the current study, it would not explain why correct recall was greater in reinstated contexts combined with high BAS conditions.

Arguably, it could be contended that BAS in the DRM paradigm may have played a more predominant role in influencing memory recall and in fact, 'overshadow' the effects of context during encoding (Isarida et al., 2012). For example, context may have become irrelevant during encoding processes, and participants perhaps only focused their attention on the semantically related information, which acted as the most beneficial retrieval cue (Woods and Dewhurst, 2018). Therefore, DRM material could even be resistant to the manipulations of image-based context (Fernandez and Glenberg, 1985) and thus provides a possible explanation for this unique result. The 'overshadowing' principle may also be applied to the false critical recall findings, as the DRM is primarily designed to stimulate the production of critical lure words (Hancock et al., 2003), and so could suggest how reinstatement of context during encoding stages may have been 'overshadowed' by such robust material with regards to free recall.

Correct free recall in conditions that combined low BAS with different contexts was significantly greater compared to recall in conditions that combined low BAS with same contexts, thus defying traditional context effect research. This finding could have perhaps been influenced by characteristics of the low BAS lists utilised in the study. For example, DRM lists containing the critical lure words of 'Whistle', 'Lamp' and 'Swift' (same context condition) as well as 'Mutton', 'Command' and 'Cottage' (different context condition) were all classified as low BAS lists according to Roediger et al. (2001). Although these low BAS lists are nearly identical regarding their BAS score, it is possible that critical word variables such as word length or frequency could have an influence on the variance of free recall (Cann et al., 2011). Findings surrounding false critical memory are particularly interesting in the context of eye witness testimony. Research of this nature may indicate how the choice of vocabulary in situations such as police interviewing may be important, as they could have a significant influence on one's ability to remember accurately (Howe et al., 2015). To some extent, the current study and previous psychological evidence may highlight how associative words could have the power to distort memory and mislead people to believe they remember something that was never actually there (Loftus, 2005; Howe et al., 2015).

Furthermore, the current experiment did not find any significant effects of context on non-critical false memory recall, contradicting previously discussed research by: Cann and Ross (1989); Brown (2003) and Goodwin (2013). As the DRM paradigm has primarily been designed to stimulate the production of false critical memories (Hancock, 2003), the fact that there was no significant main effect of BAS on non-critical false memories may not appear that surprising. Nevertheless, if the time between encoding and retrieval stages was extended, the results may have shown a different effect. For example, some odour context research has suggested that longer retention intervals may lead to more powerful CDM effects (Cann and Ross, 1989) and so, could possibly affect non-critical false memory as a result. False memories are a particularly fascinating phenomenon in psychological research (Bookbinder and Brainerd, 2016) and it would be intriguing to develop such a method as the DRM paradigm to better understand how non-associative false memories may arise without the input of a 'trigger' like critical lure words.

The present experiment provides memory research with a new, individual, and distinctive set of results that may aid the progression of visual-based context effect investigations, which is currently quite limited (Woods and Dewhurst, 2018). This study aimed to examine how the two variables of image-based context and BAS in the DRM paradigm may interact to influence memory, non-critical false memory and false critical memory, which until now, has never been conducted by any other psychological study.

It should be acknowledged that the present study achieved its initial aim of collecting 56 participants, thereby attaining the statistical target power of 80% which is considered as the 'ideal' for any sound psychological study (Wittes, 2002; Kadam and Bhalerao, 2010; Suresh and Chandrashekara, 2012). The study sample group was varied in age, ranging between 18-65 years old, as well as in gender (22 males: 34 females), thereby considering demographic characteristics of a sample to potentially generalise findings to a wider population (Banerjee and Chaudhury, 2010). However, due to utilising an opportunity snowball sampling method, the gender variable of the sample group was not equally balanced, as there were more females to males, which in turn may create a sample bias (Banerjee and Chaudhury, 2010). Despite this, the study may be merited for obtaining a relatively representative group of individuals, as well as avoiding the effects of individual differences by using a repeated measure design (Ellis, 1999). However, it is well understood that cognitive decline is highly associated with age and this may have consequently distorted the results among the elder individuals of the sample (Kukull and Ganguli, 2012). Though there were only a couple of participants who were within the elder age bracket, the experiment is principally focused on cognitive functioning and memory, thus future research should consider the age limit of the sample as it may benefit the internal validity of the study (Kukull and Ganguli, 2012).

However, there are some limitations of this experiment that need to be reflected upon. Firstly, it must be considered that the DRM paradigm utilised in this experiment was developed from Roediger et al. (2001) who adopts an American approach in the creation of DRM lists, which consequently could generate a cultural bias. For example, words referring to the critical lure of 'car' included 'highway' and 'automobile' which could perhaps not be as familiar to a British sample compared to an American sample, as DRM lists were constructed based upon American word association norms (Nelson et al., 1999). However, Woods and Dewhurst (2018) discussed that there were no significant differences found between American and British participants in correct or false recall, meaning that their data could generalise across nationality groups. Similarly, some research has indicated that the DRM paradigm may be translated into an appropriate language to suit participants involved and thus be used globally (Wang et al., 2019). Despite this, recent research by Beato and Arndt (2017) have fashioned 48 DRM lists from a British perspective, which would potentially be a beneficial alternative if this study were to be repeated in the future on a similar sample group.

Furthermore, DRM lists of words were presented orally by a female voice, which could potentially have altered the ability to recall DRM lists of words due to factors such as tone of voice and gender of the speaker (Woods and Dewhurst, 2018). Although auditory representations of DRM words provided a sense of novelty, future research could practice superimposing visual words on the background images or develop video stimuli, similar to that of Smith and Manzano (2010), and Smith et al (2014). This would ensure that participants eye focus would be maintained on the computer monitor to gain the full effect of visual context on memory recall. However, the ‘sensibleness’ of the visual stimuli integration must be accounted for as this has the potential to distort CDM results (Isarida et al., 2018). Arguably, the experiment may have induced a sense of embarrassment for some participants during the interval mathematical task presented between encoding and retrieval stages. However, Thompson et al. (2001) demonstrated that low stress conditions, do not significantly influence memory recall rates, and some arousal may in fact may improve one’s ability to remember if reinstated during learning and retrieval of information. Despite this, future research could still consider directing participants to write down the numbers instead of counting them aloud in the presence of the researcher to potentially reduce the effects of embarrassment as a confounding variable (Pessalacia et al., 2013). Another method that could be encouraged would be to ask participants to complete a fragment-completion task, similar to that practiced by Isarida et al. (2012).

In conclusion, the current study did provide research with a new and distinctive set of results concerning image-based context effects and BAS. Researchers within this field should continue to study context effects on memory using a variety of methods that will allow us to recognise what specifically may aid or distort our memories, and more importantly, potentially understand the mechanisms why. Generally, research on context effects has deemed to be quite important for a broad spectrum of real-world applications (Pardilla-Delgado and Payne, 2017) such as, eyewitness testimony and cognitive interviews (Loftus, 1979; Krafka and Penrod, 1985; Clifford and Gwer, 1999; Dando et al., 2009) educational purposes (Weir and May, 1988; Coveney et al., 2013), and potentially assist with the development of environmental reminiscence therapies (Luke et al., 2013). Therefore, context effect research is a relevant subject matter for today’s society (Bookbinder and Brainerd, 2016). However, those who practice in this research should take particular caution when discussing the overall implications of experiments using the DRM paradigm to study associative false memory, as artificial memory may not truthfully reflect false memories in the real world (Pardilla-Delgado and Payne, 2017).

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