



## Article

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# The Effect of Mood-Context on Visual Recognition and Recall Memory.

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## ABSTRACT

While it is widely known that memory is enhanced when encoding and retrieval occur in the same state, the impact of elevated stress/arousal is less understood. This study explores mood dependent memory effects on visual recognition and recall of material memorised either in a neutral mood or under higher stress/arousal levels. Participants' (n=60) recognition and recall were assessed while they experienced either the same or a mismatched mood at retrieval. The results suggested that both visual recognition and recall memory were higher when participants experienced the same mood at encoding and retrieval compared to those who experienced a mismatch in mood context between encoding and retrieval. These findings offer support for a mood dependency effect on both the recognition and recall of visual information.

*Keywords:* mood, memory, anxiety, stress

People who encode information while experiencing high levels of stress and arousal appear to have greater difficulty in retrieving the information later (Kessels, 2003; Cassady, 2004). Students sitting exams, for example, may report retrieval problems, such as that their 'mind just went blank' during the stressful assessments (Edelman, 2005). These cases of real-world forgetting may be due to an acute mismatch between the context in which the material was learnt and the context in which retrieval took place. Specifically, it has been suggested that people have difficulty in recalling medical instructions given in stressful hospital environments when they return home due to this mismatch in contexts (Kessels, 2003). Therefore, in order to improve memory when under pressure it is first important to understand how stress and arousal can affect the encoding and retrieval of information.

Previous studies have examined the impact of reinstatement of the physical learning environment on remembering (see Smith & Vela 2001 for review). Encoding Specificity theory (Tulving and Thomson, 1973), for example, suggests that the reinstatement of meaningful environmental cues at retrieval can enhance remembering. Further memory enhancement has also been observed as a result of the reinstatement of incidental cues at retrieval which were present at encoding (i.e. cues which are not obviously related to the target items). Mead and Ball (2007) investigated the context dependent effects of music and found that retrieval of newly learned meaningful information is higher when the same musical key is present at both learning and retrieval. Other studies which have examined the reinstatement of the learning environment at retrieval have found improved memory with a wide variety of physical cues, including the underwater environment (Godden & Baddeley, 1975), ambient odour (Herz, 1997) and chewing (Baker, Bezance, Zellaby, & Aggleton, 2004). This suggests that cases of real-world forgetting may, in part at least, be due to a mismatch between the environment in which learning takes place and the retrieval

environment.

However, other research suggests that a mismatch in internal mood states during encoding and retrieval, and not the physical environment, is implicated in forgetting (Eich, MacCauley & Ryan, 1994; Eich 1995). Studies have examined the impairments in memory which can occur when mood is manipulated in the laboratory (Lang, Craske, Brown et al., 2001), by medical conditions (Lam & Mansell 2008) or as a result of legal or illegal drug use (Keleman & Creeley, 2003; File, Goodall, Mabbutt et al., 1993). It has also been suggested that state dependency effects may explain more extreme forms of forgetting, such as 'red outs,' when people appear unable to remember carrying out violent crimes (Swihart, Yuille and Porter, 1999). Therefore, it may be possible to improve memory by reinstating not only physical cues but also the internal mood states present at encoding during retrieval.

Real-world applications have used the reinstatement of the physical and internal learning contexts to improve memory performance. For example, techniques such as context reinstatement used in cognitive interviews have been shown to improve eyewitness testimony (Milne & Bull, 2002; Dando, Wilcock & Milnes, 2009). Malpass and Devine (1981) found witnesses of a simulated vandalism incident were more likely to recognise the perpetrator five months later if they had first been asked to recall the physical context and their thoughts and feelings about the incident. However, in some cases of real-world forgetting the reinstatement of the learning environment does not lead to better retrieval. For example, although Thompson, Williams, L'Esperance et al., (2001) found that reinstatement of a mild stressor (a sky-diving video) did lead to an enhancement in recall, the reinstatement of a more extreme stressor (actual sky-diving) did not. Therefore it is conceivable that the nature and the severity of the environment is of critical importance when considering if forgetting can be

avoided by the reinstatement of physical context or internal mood state.

The reinstatement of extreme environments, such as sky-diving, during retrieval may therefore not help reduce forgetting, as acutely stressful experiences stop information from being encoded in the first place. There are two possible reasons why memory formation may be impaired in people under increased stress. First, when exposed to an extreme stressor people display marked neurophysiological changes (such as increases in the level of cortisol; Dickerson & Kemeny, 2004) which can impair the formation of declarative memories (Kirschbaum, Wolf, May, et al., 1996). Second, increases in novel environmental stimuli or anxiety associated with exposure to extreme environments can lead to working memory constrictions (Leach & Griffith, 2008; Robinson, Sunram-Lea, Leach & Owen-Lynch, 2008) resulting in a failure to rehearse and so encode memories into a longer-term store. As a result it could be that people experiencing high levels of stress and arousal may fail to encode information due to specific neurochemical changes or working memory constrictions. As a result, when investigating real-world forgetting in relation to memory dependency effects of stressful environments, it is important to record the level of stress and arousal that people are exposed to.

Furthermore impairments in encoding, due to the heightened state of stress/arousal, may mean that the reinstatement of a matching high stress/arousal mood state at retrieval does not enhance memory performance as the material may never have been encoded in the first place. However, in some cases, memories for traumatic events can appear lost but can be recovered later (Brewin, 2007). Thus it is possible that reinstatement of a high stress/arousal mood state could aid memory retrieval as reinstating neurochemical or cognitive workload present at encoding could unlock inaccessible memory pathways and so enhance retrieval.

Therefore this study explored whether cases of real-world forgetting could have been the result of a mismatch between the internal mood state at learning and at retrieval. As exposure to extreme stressors may lead to a failure to encode information (Kirschbaum et al., 1996; Leach & Griffith, 2008; Robinson et al., 2008) this study explored whether exposure to a mild stressor (horror film clips) could induce a mood dependency effect. Importantly, unlike previous research which has examined forgetting in stressful environments (e.g. Thompson et al., 2001), this study recorded self-reported levels of arousal and stress during the learning and retrieval phases of the study.

Further, in order to examine real-world forgetting in detail, this study examined both recognition and free recall memory. The majority of previous studies have found context and state dependency effects when looking at free recall, however the results for recognition memory are more mixed with some researchers finding an effect (e.g. Smith & Vela 1992), while others do not (Smith, Glenberg & Bjork, 1978; Smith 1979; Godden & Baddeley, 1980). These mixed findings may be explained by Smith's (1988) 'outshining' hypothesis which suggests that sometimes the recognition item can act as such a strong retrieval cue that it *outshines* the relatively weak contributions of context cues. As a result of the previous mixed findings, this study examined whether reinstatement of feelings of increased stress and arousal would act as an effective retrieval cue for both recognition and recall memory. Finally, this study looked at the recognition and recall of visual stimuli as previous studies have found that the emotional valence of verbal stimuli can affect levels of recall (for example, Eich & Macaulay 2000). Past research has also suggested that pictures are better recalled/recognised than words. Picture superiority effects are well reported in the literature (Paivio, 1971 and Weldon and Roediger, 1987) and so it will be interesting to examine

whether a mood dependency effect is still evident when using images not words. In summary, the current study will examine whether memory impairments in visual recall (symbols) and visual recognition (unfamiliar faces) in stressful situations could be the result of a mismatch between learning and retrieval mood states (high or low levels of stress and arousal).



## Method

### **Design:**

A 2 (learning context; high stress/arousal, neutral) x 2 (retrieval context; high stress/arousal, neutral) X 2 (retrieval task; recall, recognition) mixed-participants design was implemented to investigate whether state-dependency enhances recall and recognition memory.

Participants were assigned to one of four experimental groups; high stress/arousal at learning and stress/arousal at retrieval (SA-SA), stress/arousal and learning and neutral at retrieval (SA-N), neutral at learning and stress/arousal at retrieval (N-SA), and neutral at learning and neutral at retrieval (N-N). Recall performance was measured by the number of correct figures drawn, whilst recognition memory was measured by the number of faces correctly identified.

### **Participants:**

Sixty undergraduate students recruited via opportunity sampling from the University of Central Lancashire's Preston Campus took part in this study. Fifteen participants were assigned to each of the four experimental groups. All participants were over the age of 18 and were undergraduate students. Ethical approval for this study was given by the ethics board of the School of Psychology, University of Central Lancashire. Participants did not receive any reward for their participation in this study.

### **Materials and Apparatus:**

Film clips: In order to increase levels of stress and arousal two short film clips from mainstream horror movies (certificate 18) were presented. Each 8 minute (16 minutes in total) horror movie clip was comprised of two four minute clips from emotional charged scenes within the movies 'Silence of the Lambs' and 'Open Water' (Bradley, Brown, Chu, &

Lea, 2009). In the neutral mood condition, participants viewed an extract of a documentary on steam trains. Both film clips lasted 8 minutes and were displayed on a 17 in. television screen. In an attempt to remove the possible negative effects of exposure to the film clips, all participants in the stress/arousal mood condition were shown a comical cartoon clip (a seven minutes recording of Tom and Jerry) at the end of the experiment.

The Stress Arousal Checklist (SACL; Mackay, Cox, Burrows, et al., 1978) comprising two subscales was used. The stress subscale uses 19 positive and negative adjective mood-related words, such as 'Worried' or 'Peaceful.' The arousal subscale contains 15 positive and negative items, such as 'Active' or 'Drowsy.' Participants are required to select the word which best describes their current state from the options: 'Definitely Feel', 'Slightly Feel', 'Cannot Decide' and 'Definitely Do Not Feel'. A value of 1 if the positive adjectives 'Definitely Feel' or 'Slightly Feel' or the negative adjective options 'Cannot Decide' or 'Definitely Do Not Feel' are selected. Otherwise a value of 0 is given. The maximum score on the stress scale is 19 while the maximum score on the arousal scale is 15. A higher score represents higher subjective feelings for arousal and stress.

Filler task: A word search was used which consisted of 39 neutral words related to sweets and other confectionery items. The word search comprised of a twenty letter by twenty letter grid (400 letters total). The words to be identified were concealed within the grid and were presented either forward, backward or diagonally. The filler task was not scored.

Visual recall memory: A modified version of the Visual Design Learning Test (VDLT; Rey, 1964) was used which consisted of sixteen 2-D symbols presented on a 4 x 4 grid on one side of a white sheet of A4 paper. Each symbol (4cm by 4cm) was printed in black ink and

displayed in one grid box. During retrieval participants were presented with a blank 4 x 4 grid and were asked to draw as many of the previously presented 2-D symbols as they could remember.

Recognition memory: Ten head and shoulders photographs of Caucasian male and female adults were used. Each face was presented using a PowerPoint slide show displayed on a 16 inch computer monitor for a total of 4 second, with a 5 second 'blank screen' interval between photographs. During the retrieval phase, the 10 previously presented faces were integrated into a presentation of 30 faces. Participants were asked to state whether they either recognised or did not recognise each of the presented faces. False alarms were subtracted from the number of correctly recognised items.

### **Procedure:**

On entering the laboratory participants were randomly assigned to one of the four experimental groups (SA-SA, SA-N, N-N or N-SA). Those participants who encoded the visual materials while experiencing increased stress and arousal levels (groups SA-SA and SA-N) were asked to watch the horror film clips for eight minutes. The participants who encoded the visual materials in a neutral mood state (groups N-N and N-SA) were asked to view an extract of a documentary on steam trains. After viewing the film clips participants were then asked to complete a SACL questionnaire to assess whether the mood induction had been successful.

Encoding phase: Immediately after the SACL questionnaire had been completed all participants were presented with the modified VDLT task and asked to try to remember as many symbols as possible for later recall. Next participants were presented with the recognition task faces via a PowerPoint slide show. After the encoding of the recall and

recognition material participants were asked to complete a filler task (word search) for 20 minutes.

Retrieval phase: Immediately before retrieval participants were presented with a further 8 minutes of either the horror film clips (groups SA-SA and N-SA) or with the train documentary (conditions N-N and SA-N). A further SACL questionnaire to check that the correct mood had been induced was administered. Participants were then asked to draw as many of the previously presented figures from the modified VDLT task as they could recall within 3 minutes on a blank 4 x 4 grid. Participants then completed the recognition task by watching a presentation of faces via a PowerPoint slideshow. Participants were provided with a tick sheet and asked to score each face under the heading 'recognise' or 'do not recognise' as the faces appeared on screen. All participants exposed to the horror video clips were presented with a comical Tom and Jerry video clip lasting 7 minutes, to help eradicate any possible residual mood effects.

## Results

### **Mood Validation**

All participants completed a SACL questionnaire in order to establish whether the film clips had successfully induced the correct mood state. Table 1 below indicates the descriptive statistics for the stress and arousal scores across learning context and recall context.

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INSERT TABLE 1 ABOUT HERE  
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Analysis using independent *t*-tests revealed that participants in the high stress/arousal mood state at learning had significantly higher levels of stress ( $t(39.75) = -13.14, p < .001$ ) and arousal ( $t(48.83) = -9.29, p < .001$ ) than those participants in the neutral condition.

Participants in the high stress/arousal mood state at recall also reported significantly higher levels of stress ( $t(58) = -18.40, p < .001$ ) and arousal ( $t(54.63) = -12.15, p < .001$ ) than participants in the neutral condition. This indicates that a high stress/arousal mood was successfully induced.

Performance of visual retrieval ability was assessed with the Rey's (1964) Visual Design Learning Test (VDLT) and a face recognition task was used. (See Figure 1 and 2 for descriptive statistics).

A 2 (encoding context) x 2 (retrieval context) x 2 (visual retrieval) mixed-participants analysis of variance (ANOVA) revealed a significant main effect of learning context  $F(1, 56) = 35.73, p < .001, \eta^2 = .865$ ) with participants recalling more objects if learning had occurred in a neutral mood condition. There was also a main effect of visual retrieval ( $F(1, 56) = 359.78, p < .001, \eta^2 = .390$ ) suggesting that recognition of faces was significantly better than recall of figures. However, no significant main effect of retrieval context was observed  $F(1, 56) = 2.14, p = .149, \eta^2 = .037$ ) suggesting that the number of objects correctly recalled was not significantly affected by mood state at retrieval.

There was no significant interaction between the type of visual retrieval (faces or figures task) and the encoding context ( $F(1, 56) = .325, p = .571, \eta^2 = .006$ ) or between type of visual retrieval and context at retrieval ( $F(1, 56) = .133, p = .717, \eta^2 = .002$ ). However, in line with the hypothesis a significant interaction was found between encoding context and retrieval context ( $F(1, 56) = 31.52, p < .001, \eta^2 = .360$ ) with participants performance in both tasks being better in the matched rather than the mismatched contexts.. In light of Trafimow and Rice (2009) paper further post-hoc analysis was deemed unnecessary since although significant differences may be informative, non-significant outcomes cannot be readily interpreted therefore undermining the utility of the exercise.

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INSERT FIGURE 1 ABOUT HERE  
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INSERT FIGURE 2 ABOUT HERE  
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In order to rule out the possibility that better memory performance was observed due to the matching of the cognitive context of the film clips presented and not as a result of matching mood states further internal analysis using zero order correlations was completed. Over all, across all participants a significant negative correlation was found between the difference in stress at encoding and retrieval and memory performance with a greater difference being associated with poorer recognition ( $r=-.41, p<.01$ ) and recall ( $r=-.31, p<.05$ ) memory. A significant negative correlation was also observed between the difference in anxiety levels between encoding and retrieval and recognition ( $r=-.30, p<.05$ ) and recall ( $r=-.27, p<.05$ ) memory.

Further correlational analysis was completed with participants divided into two groups; those who had experienced matching (SA-SA, N-N) or a mismatching (SA-N, N-SA) context during the experiment. The results suggested that those in the mismatching group had a significant negative correlation between the difference in stress experience at encoding and retrieval and their recognition ( $r=-.71, p<.001$ ) and recall memory ( $r=-.50, p<.01$ ). A significant negative correlation was also observed for anxiety, with greater differences in anxiety between encoding and retrieval and their recognition ( $r=-.68, p<.001$ ) and recall ( $r=-.54, p<.01$ ). No significant correlations were observed in the matching context group.

However, this is likely to be due to the greater homogeneity in the stress/arousal measures within the matching group. Overall, these results suggest that memory performance is modified in this study as a result of stress and anxiety levels and not due to differences in cognitive context of the films used.

## Discussion

This study aimed to determine whether people have poorer visual memory performance due to a mismatch between the levels of stress/arousal experienced during encoding and retrieval. Our results provide support for a mood dependency effect in the recognition and recall of visual stimuli. Participants who experienced the same internal mood state (either neutral or high stress/arousal) at learning and retrieval fared significantly better on both the recognition and recall tasks than those who experienced mismatch context. Therefore, our results support the hypothesis that mismatched mood states between encoding and retrieval can explain instances of real-world forgetting..

Previous studies have shown that meaningful context cues result in higher levels of recall (Tulving and Thomson, 1973). In addition, incidental cues such as context or mood dependency effects can also lead to better recall of verbal stimuli (Baddeley, 1975; Baker et al., 2004; Eich et al., 1994; Godden & Smith, 1979). Our study suggests that a mood dependency effect can also occur when people attempt to retrieve visual material. Poorer visual memory was observed when visual material encoded during heightened stress/arousal is not reinstated on retrieval. This finding may help to explain why people who encode visual information in a high state of stress/arousal, such as during a violent crime, may have poorer memory if retrieval takes place when stress/arousal is lower.

In addition, the results of our study indicate that reinstatement of the internal mood state of a heightened level of arousal and stress at retrieval can improve both recognition and recall memory. This is interesting as previous findings suggest that recognition memory is not always improved with the reinstatement of people's internal mood state (Smith, et al., 1978;



Smith 1979; Godden & Baddeley, 1980). Smith (1988) suggests that the reason for past failures to find context or state dependency effects when using recognition tasks is that the materials to be recognised act as a strong retrieval cue and so 'outshine' the contribution of the context or state. However, participants in this study did show better performance in their recognition of visual material when the same mood context was present at learning and at retrieval. This suggests that state context cues are not always outshone and that people's ability to recognise visual material can benefit from the reinstatement of internal mood cues. Further research could examine if the picture superiority effect (Paivio 1971) means the contribution of physical or mood contexts are less likely to be 'outshone' when people are recalling visual not verbal stimuli.

Changes in internal mood have previously been suggested as a reason as to why real-world forgetting may occur. Our results offer support for Kessels' (2003) observation that people have a poorer memory for information learned under stressful conditions, such as a hospital, but retrieved in a more relaxed context, such as at home. In addition, our study suggests better visual recall and recognition memory will be observed if people retrieve information in the same mood context as encoding occurred. Our results suggest that this is true for both matching high stress/arousal mood contexts or matching neutral mood contexts. It would be unethical to suggest to police officers, for example, to increase levels of stress/arousal in eyewitnesses so that levels of stress/arousal match those experiences at encoding purely in order to improve their memory of criminal acts. However, more ethical approaches which help to access thoughts and feelings which occurred during encoding, such as the use of cognitive interviews should be considered. In addition, our results support Cassady (2004) suggestion that students during exams may have reduced memory performance due to a mismatch between mood at encoding and retrieval. This suggests that exam performance for

students could be improved if relaxation techniques were taught in order to reinstate a neutral mood which is more likely to have been present during exam revision.

Although, this study gives support for a mood state dependent memory effect, it should be remembered that only a small change in participant's levels of stress and arousal was induced. Previous research (Smith, 1988) has suggested that the strength of the state or context is important, with stronger state/contexts resulting in a stronger state or context memory effect. However, this may not be the case when the mood state relates to increased levels of stress and arousal. For example, while we found a partial mood dependency effect relating to the reinstatement of a mild stressor at retrieval, Thompson et al., (2001) found no such benefit in the reinstatement of a more extreme stressor (sky-diving). Therefore it could be that the nature and the severity of the context are of critical importance when considering if memory can be improved by the reinstatement of physical context or internal mood state. As a result of this observation future research is needed that not only examines the effect of different types of mood context on retrieval but also different levels of mood intensity.

Future research should also bear in mind that the ability to encode new memories can be impaired during exposure to extreme levels of stress/arousal due to a number of reasons. For example constrictions in working memory or neurochemical changes have both been shown to reduce people's ability to encode material into declarative memory (Robinson et al., 2008 and Kirschbaum et al., 1996). As a result researchers should remember that attempts to improve memory by reinstating mood contexts could fail simply because the material has never entered the long-term memory. For example, it is possible that 'red outs' (the supposed inability to recall carrying out a violent crime) are the result of a mismatch between the

internal mood state at the time of the crime and the later mood state (Swilhart et al., 1999). Further, it is also possible that extreme levels of stress and arousal cause other physiological or cognitive changes which result in the memories not being encoded in the first place. Therefore, it is critical that future studies looking at mood dependency effects measure the strength of the mood induced, as we have done in this study. In addition, if the mood to be induced has been shown to interfere with memory formation, researchers should consider measuring other factors which have been associated with failures in memory, such as neurochemical changes e.g. in cortisol.

In conclusion, the present study suggests that when the mood state present at encoding is reinstated at retrieval (whether a neutral or a heightened stress/arousal mood) people's recall and recognition memory for visual material can be enhanced. Follow-up studies should consider the effect of reinstatement of different types of mood on visual memory as well as the effect of different levels of mood intensity.

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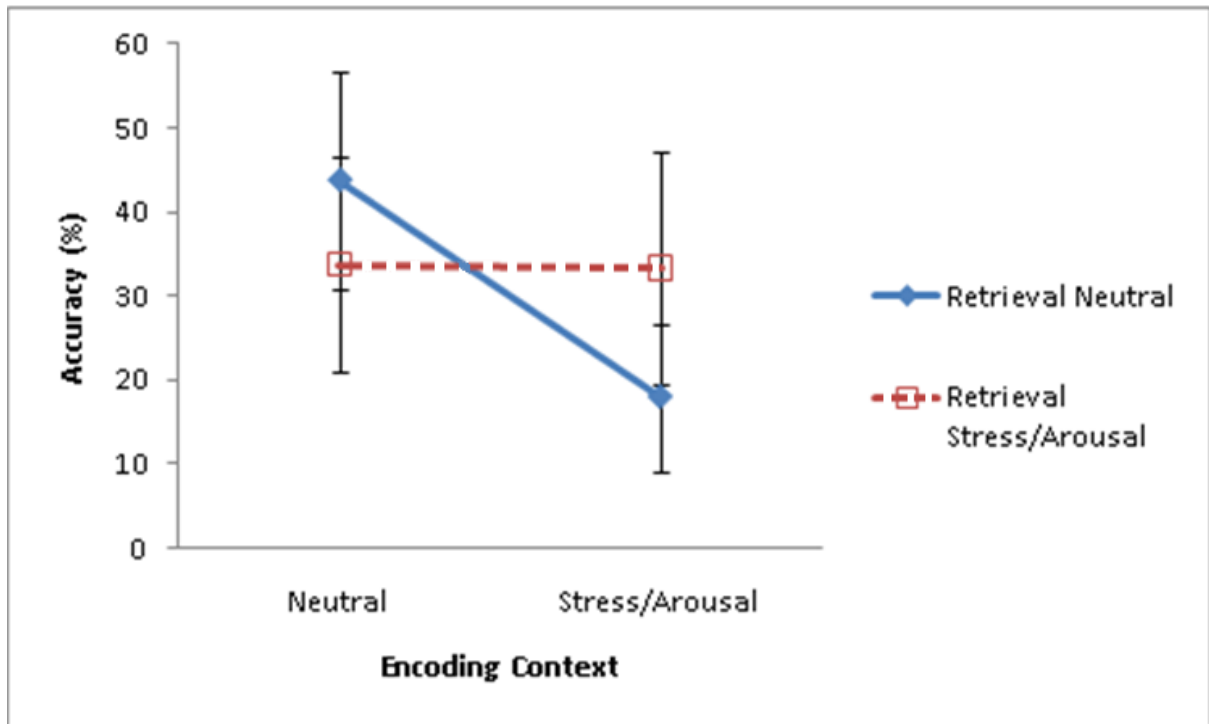
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Table

**Table 1: Mean participant scores (with standard deviations) on the SACL questionnaire for participants at encoding and retrieval in both conditions (stress/arousal and neutral).**

	Encoding			Retrieval		
	Neutral Context	S/A Context	Mean Total	Neutral Context	S/A Context	Mean Total
Neutral Context						
Stress levels	2.27 (1.53)	1.200 (.77)	1.73 (1.31)	1.33 (.96)	11.07 (1.39)	6.20 (5.09)
Arousal levels	6.00 (1.13)	5.53 (1.73)	5.77 (1.45)	4.80 (1.32)	11.93 (1.79)	8.37 (3.94)
S/A Context						
Stress levels	10.07 (2.66)	9.07 (3.31)	9.567 (2.99)	1.93 (1.98)	10.47 (2.85)	6.20 (4.96)
Arousal levels	10.40 (2.29)	10.40 (2.41)	10.40 (2.31)	6.20 (1.74)	11.20 (2.48)	8.70 (3.30)



**Figure 1. Mean recall accuracy (with standard deviations) on the Rey's visual recall (1964) task for participants experiencing either the anxiety or neutral mood state at encoding or retrieval.**

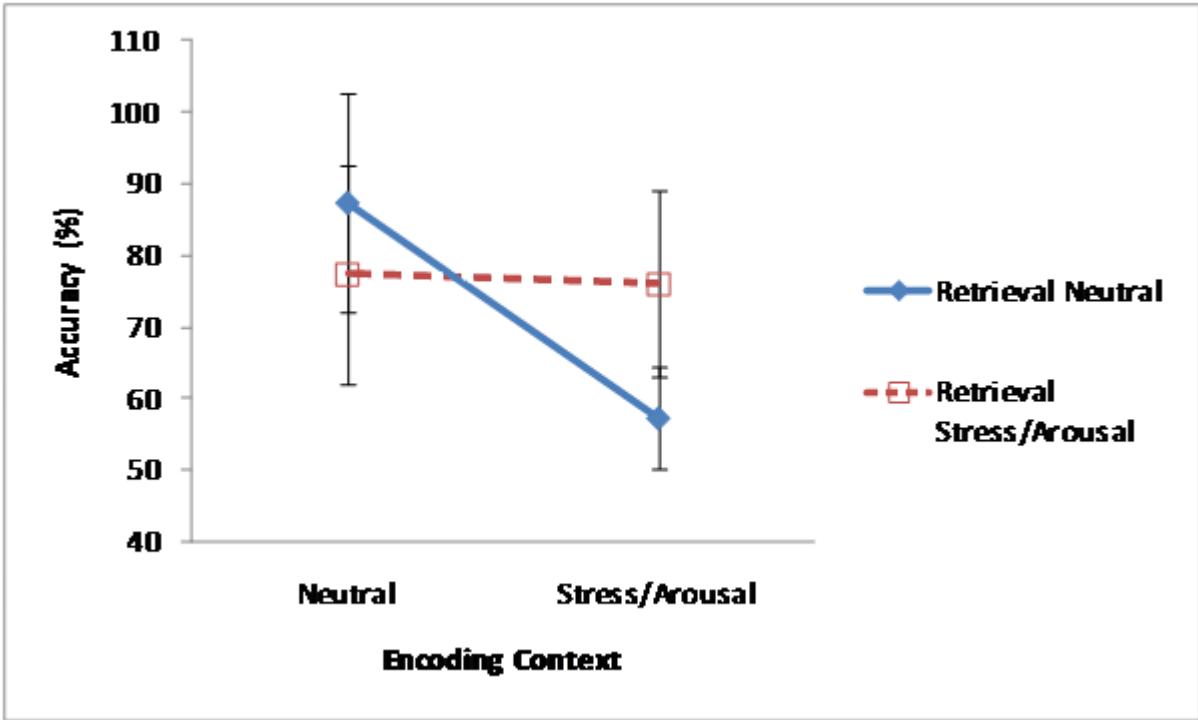


Figure 2. Mean recognition accuracy (hits minus false alarms; with standard deviations) on the face recognition task for participants experiencing either a heightened stress/arousal or neutral mood state at learning or retrieval.