The Effect of Stress at the Retrieval Stage of Eyewitness Recall

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The Effect of Stress at the Retrieval Stage of Eyewitness Recall

by

Mary-Anne Martin

A Thesis Submitted in Partial Fulfilment of the
Requirements for the Award of
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Abstract

Although stress at the encoding stage of eyewitness memory has been studied in depth in the literature, little is known about the recall stage. Stress effects on retrieval were investigated in two experiments to examine its impact on recall, repeated testing, and accuracy. Stress was manipulated by evaluative threat and time pressure at either immediate and/or delayed recall (20 minutes) in four experimental conditions in Experiment 1. Participants were 62 undergraduate students from Edith Cowan University. A series of 40 pictures, five to a slide, were shown by overhead projector at the rate of 20 seconds per slide. There were no differences between groups for reminiscence, i.e. all groups recalled new items at delay. At immediate recall groups did not differ for the number of items recalled, however at delay the immediate stress delayed no stress group showed moderate hypermnesia and differed significantly from the other groups, who showed a decrease in recall. All groups made significantly more errors at delay, and there were no differences between groups for the number of errors made. In Experiment 2, participants were 65 metropolitan bank staff members assigned to the same experimental conditions as in Experiment 1, who were shown a series of 12 slides depicting a handbag snatch, at the rate of 5 seconds per slide. Stress was manipulated by time pressure and by emphasising the importance of accuracy. All groups showed reminiscence, but the stress at immediate recall groups showed significantly higher reminiscence than the no stress at immediate recall groups. There were no differences between groups for immediate recall, but the immediate stress groups remembered significantly more at delay (hypermnesia). The no immediate stress participants did not differ from immediate to delayed recall. No differences between groups were found for overall
errors. Separate chi-square analyses of errors for offender, victim and scenario at immediate and delayed recall showed that the stress at both recall group made significantly less errors about the offender at delay. The major finding in both studies was that stress does not appear to have an adverse effect on recall, and in some cases may have a facilitatory effect if manipulated at immediate recall.
Declaration

I certify that this thesis does not incorporate, without acknowledgement, any material previously submitted for a degree or diploma in any institution of higher education and that, to the best of my knowledge and belief, it does not contain any material previously published or written by another person except where due reference is made in the text.

Signature

Date
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Firstly I would like to thank my supervisor, Professor Don Thomson, who has tried to keep me on track although I don’t think it has always been too easy for him. It has been a pleasure to work with and learn from him. Thanks also to Dr. Adele Hills for putting me straight about my split plot ANOVA assumptions.

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Thanks also to my victim (Gwen) and offender (Milo) and to Mike for the use of his “getaway car”. The number plate and your descriptions are indelibly stamped in my mind! Finally to my participants, a big thank you - because without you it never would have happened.
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Chapter One

The Effect of Stress at the Retrieval Stage of Eyewitness Recall.

The influence of stress on eyewitness memory has been well represented in the eyewitness literature (Christianson, 1992; Deffenbacher, 1983, 1991). Although eyewitness stress has been studied in depth, studies have usually focused on when the to be remembered event was being experienced - the encoding of the event. In contrast, little is known about stress at the time of recall or recognition - the retrieval of the event. Research into retrieval is relevant to those who are involved in obtaining statements from witnesses to a crime. The identification of factors which facilitate or inhibit recall is pertinent to investigations. Previous eyewitness research into factors affecting retrieval has already identified ways to improve line-up and interview techniques (Deffenbacher, 1991; Thomson, 1995). The effect of stress on the witness at the time they give their statement should also be considered.

The research to be reported in this thesis concerns the effect of stress on both immediate and delayed recall, and also investigates the effect of stress on multiple testing. The literature on stress and repeated testing will be reviewed.

Stress
Stress - Definitions and Theoretical Concepts

The terms stress, anxiety and arousal are often used interchangeably in the psychological literature (Spielberger, 1972). In the present thesis they will also be used interchangeably due to the overlap in many of the studies into this area.
There are two prominent theories advanced to explain the effect of stress or arousal on eyewitness memory performance. One is Easterbrook's cue utilisation theory (Easterbrook, 1959) and the other is the Yerkes-Dodson (1908) inverted U hypothesis, also called the Yerkes-Dodson law.

The Yerkes-Dodson law (1908) states that arousal and performance occur on a continuum. An increase in arousal from a resting state to very high levels of arousal would result in an initial improvement in performance, up to an optimal arousal point, at which time performance declines. Where the optimal arousal point is located depends on the difficulty of the task, with easy tasks under high arousal leading to better performance, and the opposite effect for more difficult tasks. One problem with this explanation of the effects of stress is that it is difficult to determine both the level of arousal and task complexity at which performance is either enhanced or decreased (Baddeley, 1972; Christianson, 1992).

Deffenbacher (1983), in his review of the literature into eyewitness stress, found ten studies which supported an increase, or no impairment, in accuracy; and eleven studies which found a decline in accuracy. These studies used a variety of measures (facial memory, landscapes, person and scenario descriptions); and a variety of stressors (staged and filmed crimes of varying violence levels, white noise, ego threat, and electric shock); and this is one of the difficulties in generalising results to other studies. Deffenbacher concluded that the differences in witness accuracy were due to their different arousal stages on the Yerkes-Dodson (1908) curve. This conclusion was based on whether performance was impaired or not: those studies finding a poorer performance must have had higher arousal and therefore fell on the right hand side of the curve; and those which found facilitation of performance had
lower arousal and fell on the left hand side of the curve. As Christianson (1992) argues "This means, in principle, that all studies fit the Yerkes-Dodson (1908) law and the inverted-U hypothesis is therefore nonfalsifiable" (p. 297).

A contrasting view of the Yerkes-Dodson law (1908), from Ebbeson and Konecni (1997), suggests that the U shape is an upright U, with both high and low stress levels supporting better memory, and medium stress lowering memory performance. This view would appear to be more consistent with some of the diverse findings often found in the literature about stress on performance, particularly those which find improved memory under high levels of arousal, however it still suffers from the same difficulties in locating the optimal arousal and task difficulty levels on the curve.

Cue utilisation theory (Easterbrook, 1959) states that under stress the attentional focus is narrowed so that more attention is paid to the central task at the cost of more peripheral tasks. In other words under high stress, details that are attended to are better remembered and memory for those details which were not attended to is poorer (Ebbeson & Konecni, 1997). The effect of stress on performance is thus dependent on what aspect of memory is measured. For example, in a study by Loftus and Burns (1982) memory for the number on a boy's football jersey (a peripheral detail), was worse for those who saw the boy being shot, however there was little difference between groups for the central details of the film. Christianson (1992) suggests that a narrowing of focus is accompanied by the likelihood that emotional events are rehearsed more after the event. This post event rehearsal or "post-stimulus elaboration" contributes to better retention of emotional events according to Christianson.
An alternative view of attentional narrowing is explained in terms of the effect of anxiety on performance, which has generally centred on the phenomenon of test anxiety. Test anxious participants have been found to redirect attention to task irrelevant thinking, which reduces the attention available for processing (Eysenck, 1977, 1982). According to Wine (1971), attention is directed towards self-evaluative worrying in highly test anxious individuals. Anxiety involves both physiological (emotional) and cognitive (worry) components according to Eysenck (1983). He suggests that with physical risk emotionality is increased; whereas with ego threat worry is higher. Liebert and Morris (1967) defined emotionality as the autonomic arousal aspect of anxiety, and worry as the cognitive concern over performance. It is this worry which distracts memory processes when susceptible participants are placed under evaluative threat according to Hedl and Bartlett (1989).

The Manipulation and Measurement of Stress

Ego or evaluative threat is generally manipulated by giving participants negative or failure feedback on their task performance, or by indicating that their performance is related to intellectual ability. Typically participants are separated into high and low trait anxiety based on their scores on a state-trait anxiety instrument, and their performance under stress is then compared. Trait anxiety refers to “relatively stable individual differences in anxiety proneness” (Spielberger, 1972, p.39) and therefore a higher susceptibility to anxiety in stressful situations for highly trait anxious individuals (Eysenck, 1983). State anxiety is situationally determined (Eysenck, 1983), and refers to “a transitory emotional state...that varies in intensity and fluctuates over time...characterized by subjective, consciously perceived feelings...”
Stress at Recall

of tension and apprehension, and activation of the autonomic nervous system" (Spielberger, p. 39).

Loftus and Doyle (1992) point out that the “symptoms of ... high anxiety or stress can include changes in heart-rate, trembling and perspiring” (p.31) and are often experienced by witnesses to crimes. They add that even without these physiological changes, a high level of arousal can occur. Furthermore, there are some difficulties with the use of physiological measures.

Teichner (1968) argues that in any given situation, “physiological measures may increase, decrease, or not change at all” (p. 282) and therefore no one measure can be considered reliable in the assessment of arousal. There are differences in definitions; measures used (both physiological and behavioural); and methodology. All of these differences make it difficult to compare studies and their outcomes. Hodges (1968) found that participants reacted differently to threat of failure and threat of harm due to electric shock. High trait anxiety participants responded to ego threat with higher state anxiety levels than those with low trait anxiety. The same interaction was not found with threat of electric shock.

There are various methods of manipulating stress. Eysenck (1977) describes studies using white noise, sleep deprivation, electric shock, and drug injections; eyewitness studies frequently use viewing of horrific or violent slides, (Christianson & Loftus, 1987; Clifford & Scott, 1978; Kramer, Buckhout, Fox, Widman, & Tusche, 1991). Decision making studies have often used the manipulation of time pressure to create stress (Edland & Svenson, 1993). Leon and Revelle (1985) used a combination of time pressure and evaluative threat to create stress in a study on analogical reasoning. Hockey and Hamilton (1983) have attempted to provide an overview of
the changes in performance with different types of stressors. They argue that different
types of stressors have different effects on performance and the different types of task
measured, for example anxiety has an escalating effect on alertness and sleep
deprivation has a negative effect on alertness.

Given these findings, the experimental manipulation of a stressor should, as
closely as possible, reflect the type of effects found in the situation that researchers
are trying to replicate. It is argued here that two different types of stressor may be
implicated in an eyewitness situation. First, the event itself may involve a threat of
harm; and second, the task of retrieving witnessed events may involve a different
stressor, evaluative threat. Evaluative threat may occur because: (a) the witness is
required to recall as much as possible about an observed event; (b) for many
witnesses it may be the first time they have been in a police station or courtroom; (c)
they may feel stress through the pressure to provide an accurate report to
investigators; (d) they may feel intimidated by being interviewed by the police or
lawyers; (e) and there may be time pressure. Threat of harm may be present if: (a) the
witness also fears retribution from the offender; (b) or if they are scared to come face
to face with this person (Dent, 1977); (c) or they may still be experiencing residual
stress from the crime they have just witnessed.

**Stress at Encoding**

Most of the research into stress and memory processes has focused on the
encoding stage of memory. Although the present study is only interested in processes
at retrieval, it is possible that effects may be similar to those at encoding (Tulving,
1964). For this reason the following studies of arousal at encoding have been included to illustrate how stress might affect retrieval processes.

Many of the studies on the effect of stress and arousal on memory have been conducted using paired associate learning tasks. Chiles (1958) presented participants with word pairs, some strongly associated and some weakly associated. Throughout presentation, participants received either mild electric shock or the sound of a buzzer. Overall, those who received electric shock performed better on both the associated and non-associated word pairs. Those in the electric shock group who had higher scores on the Manifest Anxiety Scale (MAS) performed better than their non-anxious counterparts, suggesting motivation to avoid threat of harm may play a role in performance.

Naturally occurring arousal, as opposed to arousal which has been manipulated, has also been used to measure performance. In these studies participants' physiological responses to words are measured and then memory for the words which generated arousal is analysed (Kleinsmith & Kaplan, 1963, 1964; Levinger & Clark, 1961). It could be argued that pleasant and unpleasant stimuli may both produce arousal, but that arousal with pleasant stimuli does not mean the participant is suffering stress. However in a study in which participants initially rated pictures for emotional and arousal content, free recall for these pictures was measured at immediate recall and a delay of one year (Bradley, Greenwald, Petry, & Lang, 1992). Results showed no difference in memory for pleasant or unpleasant stimuli, but rather that memory performance was influenced by the level of arousal to that stimuli. It has already been determined that arousal accompanies stress (Loftus &
Given these findings, the following studies on arousal may have some relevance to memory performance under stress.

A fairly frequent finding in the studies into arousal at encoding is that immediate recall performance is poorer, whereas performance at delay shows an improvement. Kleinsmith and Kaplan (1963) found arousal increased the percentage of high arousal items recalled at delayed recall (20 minutes, 45 minutes, 1 day & 1 week) as opposed to immediate recall. The reverse effect was found for low arousal items, immediate recall was higher than delayed. They used a paired associate learning task which paired some high arousal words (such as vomit and rape) and some low arousal words (such as dance and swim), with digits. This study was followed up with another study using nonsense syllables (Kleinsmith & Kaplan, 1964). The same pattern of results was found - with immediate recall lower and delayed recall higher for the high arousal items, and the opposite effect for low arousal items. In both studies, high and low arousal were measured by skin resistance to the words or nonsense syllables. Similar results to the Kleinsmith and Kaplan findings, were also found by McLean (1969) using white noise as the stressor. This improvement in recall across tests occurs because arousal increases the strength of consolidation in memory, making it more easily accessible at delay, but poorer because of interference at immediate recall according to McLean.

Prior to these studies, it was generally thought that poor performance at recall was due to repression of emotional information. Levinger and Clark (1961) found that more word associations were forgotten when the stimuli were emotional words than for neutral stimulus words. Their study was later extended by Parkin, Lewinsohn and Folkard (1982), to include a delayed recall test. Parkin et al. also found that recall was
poorer at immediate testing, but forgetting was lower for emotional materials than for neutral materials at a delay of one day. If forgetting were due to repression, the results found at delay would not be better for the emotional group. Parkin et al. concluded that different levels of optimal arousal may apply to immediate and delayed recall.

Another explanation is that other researchers have found both retrograde and anterograde amnesia for items immediately prior to or after a violent or arousing event. (Loftus & Burns, 1982; Tulving, 1969). Arousal at encoding may produce this retrograde amnesia for items encoded prior to the arousing stimulus. By the time of delayed recall recovery effects may have occurred according to Christianson (1992). It is possible that the same effect may be found for participants who experience arousal prior to or during retrieval, with recovery of items available to recall at later testing.

**Stress at Retrieval**

In fact an improvement in memory over time for arousing events is not limited to arousal at encoding. Uehling and Sprinkle (1968) induced arousal immediately before recall of a serial list. There were three conditions: relaxed, muscle tension, and white noise. Immediate recall did not differ between groups, but delayed recall was better after 24 hours and 1 week for the white noise group, compared to the other groups. A probable explanation for the lack of difference at immediate recall was that participants were already near the peak of their performance because they had learned the list to criterion of one perfect trial. However facilitation of white noise arousal on later memory was possible because forgetting had occurred. The only measure of the manipulation was the recall test. Although muscle tension was used here to induce arousal, Uehling and Sprinkle suggested that the muscle tension manipulation had been unsuccessful due to a lack of suitable measurement of tension
Stress at Recall

and participants' unfamiliarity with the equipment used. This points to the difficulty in trying to compare various stressors which may induce differing arousal levels.

Outside the laboratory, some studies into stress on recall have used naturally occurring stress to study its effects. Anxiety about examinations and public speaking are good examples of this type of stress. The ensuing research has measured stress effects at retrieval but has not looked at multiple testing or delay. The following quote from Mosso (1896) about his first public speech gives a tangible account of the impact of stress on his performance:

Never shall I forget that evening. From behind the curtains of the glass door I peered into the large amphitheatre crowded with people. It was my first appearance as a lecturer, and most humbly did I repent having undertaken to try my powers in the same hall in which my most celebrated teachers had so often spoken. All I had to do was communicate the results of some of my investigations into the physiology of sleep and yet, as the hour grew nearer, stronger waxed within me the fear that I should become confused, lose myself and finally sound gaping, speechless before my audience. My heart beat violently, its very strings seemed to tighten, and my breast came and went as when one looks down into a yawning abyss .... As I cast the last glance at my notes, I became aware, to my horror, that the chain of ideas was broken and the links lost beyond recall .... Long periods which I thought myself able to repeat word for word - all seemed forgotten .... There was a singing in my ears .... After a few sentences jerked out almost mechanically, I perceived that I had already finished the introduction to my speech .... Trembling of the hands ... my knees shook ... my trembling voice ... I was perspiring, exhausted. (pp. 1-3).
The feelings evoked by this passage would be familiar to most people who have spoken in public at some time. It identifies many factors often associated with the effects of evaluative threat – state anxiety and worry.

Idzikowsky and Baddeley (1983b) utilised the fear of public speaking in their study on the effects of anxiety on performance. They noted participants' changes in heart rate as well as obtaining adjective checklist subjective measures. The subjective measures showed that participants were more alert, excited, energetic, troubled and tense. There was a small decline in performance on digit span and verbal fluency tasks when speakers were measured prior to giving their talk. As the authors pointed out, however, the speakers were not yet at the peak of their anxiety. Heart rate measures were taken leading up to and throughout the speech; these measures peaked at the start of the talk and remained high throughout, suggesting that greater impairment may have been found for performance measures during the talk. This study was followed up by the authors using first time parachutists as participants (Idzikowsky & Baddeley, 1987). Again they found decreased performance in digit span and also poorer performance on logical reasoning tasks and letter search tasks.

In both these studies, an alternative explanation could be that poorer performance was not related to stress, but rather to the fact that participants were concentrating on the talk they were about to give or the parachute jump they were about to make. It is likely that the performance measures were not seen as relevant to the participants being measured.

A series of studies using performance measures more relevant to the stressor have shown that the stress generated by dangerous situations can lead to a failure in recall. Berkun, Bialek, Kern and Yagi (1962), using servicemen as their participants,
simulated an emergency situation during an airplane flight. The situation involved a crash landing and the servicemen were asked to complete: (a) a form regarding disbursement of their possessions; and (b) a multiple-choice test of emergency procedures they had reviewed before the flight commenced. The cover story was that the insurance company would require evidence that the necessary precautions had been taken. The disposition of personal belongings task was made more difficult by the deliberate use of poorly designed forms and was scored according to how well the participant had followed instructions. The emergency procedures test was scored by the number of correct answers to the multiple choice test. The experimental group performed significantly more poorly on both tasks (with a mean of 4.9 out of a possible 12 for the emergency instructions test; and 35.3 of a possible 50 for the personal belongings task) as opposed to two control groups who remained on the ground or did not have an emergency situation during their flight (combined mean 8.8 for the emergency instructions test; and 39.7 for the personal belongings task). Stress was measured by urinary analysis for hyperactive adrenal output and participants' responses to items on a list of affective words. These measures showed that those exposed to the emergency situation were more stressed than the control groups. This research, while maintaining high levels of realism, would not pass ethical clearance today although it gave a good indication of soldiers' possible performance levels in dangerous situations.

Another problem with the work on dangerous or fear-inducing situations is that the research is carried out on people who have placed themselves in the stressful situation voluntarily: from soldiers to parachutists to deep sea divers to those who speak in public (Baddeley, 1972; Berkun et al. 1962; Idzikowsky & Baddeley, 1983a,
The same cannot usually be said of a victim or witness of crime. In the case of a crime, the act occurs suddenly and unexpectedly. There may be differences in the witness' reaction to stress, compared to those who seek excitement willingly. Baddeley (1972) reported that level of experience differentially impacts on the level of arousal. For example, first time parachutists have different stress patterns to regular jumpers: novices increasing in arousal right up to the jump, whereas more experienced parachutists experienced stress on the morning of the jump and then on landing. Berkun et al (1962) also found that experienced soldiers had different subjective stress scores to inexperienced soldiers when placed under stress.

It is conceivable then that stress affects performance differently: based on the source of the stress; the level of experience the participant has previously had with the stressor; participants' tendency to avoid or seek out highly arousing situations; the difficulty of the task; and the level of preparedness participants may have for the situation. The variability in different responses to stress suggests that any separation into groups based on these differences means that other aspects of stress will be ignored. It is not possible for the police or the courts to separate witnesses into those who may or may not perform better under stress. For this reason there seems little to be gained by doing so in the present study.

Stress and Accuracy

As with the literature on stress and memory performance, the results are also variable when it comes to the accuracy of memory under stress. Bradley et al. (1992) found that less recognition errors were made on slides which had been rated as highly arousing, compared to those rated with low arousal. Mueller, Miller, and Hutchings
Stress at Recall

(1979) also found that high anxiety had no affect on false alarm rates in a picture recognition task. Conversely, in a study of facial recognition, Mueller, Bailis and Goldstein (1979) found that high anxiety participants made more false alarms than low anxious participants.

Negative feedback (a form of evaluative threat) was found to lead to more confabulations by participants in a study by Tata and Gudjonsson (1990). They suggested negative feedback was related to anxiety making highly anxious participants more likely to "shift" their responses in an attempt to get the right answer. This incorrect schema was maintained after a 1 week delay, showing that errors are retained over time. The same results were not found for white noise stress, possibly because white noise was not seen by participants as being relevant to the task they were completing. In a study using both time pressure and evaluative threat, Leon and Revelle (1985) suggested that time pressure may produce a speed / accuracy trade-off. They found this was the case for both high and low anxious participants in their study of anxiety on analogical reasoning problems. They also found that as the task became more difficult, more errors were made.

In the eyewitness domain, participants who had been exposed to a syringe (to simulate a weapon effect) were more likely to make false alarms (Maass & Kohnken, 1989). However in a study of actual eyewitnesses to crime, Christianson and Hubinette (1993) reported that accuracy for highly stressed witnesses was high when compared to police reports. Christianson (1992) in his review of the literature on eyewitness stress argued that emotional events are retained accurately over time and that arousal was more likely to increase accuracy than to have a detrimental effect. This is not the general consensus however, a survey of eyewitness experts (Kassin,
Ellsworth & Smith, 1989) found that the majority of respondents believed that high levels of stress impaired eyewitness accuracy.

Despite this belief, in studies which have looked at repeated testing of witnesses, the error rate is not found to significantly increase over trials (Dent & Stephenson, 1979; Martin & Thomson, 1994), this finding was also found with filmed crimes - stimuli which have often been shown to be emotionally arousing (Dunning & Stern, 1992; Scrivner & Safer, 1988; Turtle & Yuille, 1994). This would suggest that both the act of repeated testing and the use of arousal manipulations do not tend to result in increased errors made by participants.

Repeated Testing

As well as the finding that errors are not increased by repeated testing, a common finding is for an improvement in the number of items recalled over tests. Although arousal is not necessary to produce this finding, the forgoing studies on arousal at encoding found reminiscence effects. Improvements across tests are known as reminiscence and/or hypermnesia. Payne (1987), in a review of the literature on hypermnesia and reminiscence, made the following distinctions between the two concepts: (a) reminiscence pertains to the recall of items which were not recalled on previous tests; and (b) hypermnesia refers to the increased recall of items over repeated recall tests.

Research into the area of hypermnesia grew in the 1970s according to Payne (1987). Erdelyi and Becker (1974), using a repeated recall procedure, demonstrated that it was possible to obtain a net increase in the number of pictures recalled by participants; the same effect was not evident for recall of words. The experiment
involved showing participants lists of pictures or words and then testing for recall of the items. Participants were given three recall tests of seven minutes duration each. Hypermnesia has been found under a variety of conditions: using both repeated tests or one continuous 21 minute recall (Roediger & Thorpe, 1978); varying the retention time of the first recall test (Roediger & Payne, 1982); using only two recall tests of shorter duration (Madigan & Lawrence, 1980); and using different recall instruction conditions (Erdelyi & Becker, 1974; Madigan & Lawrence, 1980; Roediger & Payne, 1982, 1985).

In Payne's review (1987), a hypermnesia effect was found for pictures in 49 out 51 cases examined. However, a more important finding with repeated testing is the remembering of previously unrecalled items - or reminiscence. It has been suggested by some researchers that reminiscence is an even more reliable finding than generally thought (Belmore, 1981; Turtle & Yuille, 1994), although its validity was questioned in the early literature where it was argued that reminiscence was merely due to practice effects according to Payne. The act of recalling items became another instance of learning or "recall of recall" (Mandler & Parker, 1976, p.46). Tulving (1964) also noted that practice led to improved recall of verbal materials, due to the organisation of items within lists as recall tests progressed, and that increases in recall were dependent upon this organisation. It may be that the use of meaningful stimuli, as is usually the case in reminiscence studies, allows this organisation in memory to take place. This should have implications for the eyewitness area. Witnesses often tell their story more than once: to the police, family and friends, counselors, and finally the courts (Eugenio, Buckhout, Kostes, & Ellison, 1982).
Repeated Testing in Eyewitness Recall

In fact several studies in the eyewitness domain have investigated the effects of repeated testing on eyewitness recall (Dent & Stephenson, 1979; Dunning & Stern, 1992; Eugenio, Buckhout, Kostes, & Ellison, 1982; Martin & Thomson, 1994; Scrivner & Safer, 1988; Turtle & Yuille, 1994). Eugenio et al. showed a series of slides showing an assault in a prison setting. Participants were interviewed for three 5 minute periods, with a 5 minute break separating recall trials. During the retention intervals, participants either played a game as a distractor or spent time thinking about the incident they had watched. Their finding overall was that while moderate increases in hits occurred, there were also increases in errors across trials, therefore hypermnesia did not occur.

A later study by Scrivner and Safer (1988) used a filmed event and a fairly standard hypermnesia procedure (three 7 minute trials at the first session, and a further recall trial 48 hours later). They found net increases in recall across trials (participants recalled more details on each trial than they lost), or hypermnesia. They reported that errors across trials were small in comparison to the gain in correct items recalled.

Turtle and Yuille (1994) have criticised Scrivner and Safer’s study on the basis that it was not forensically sound. They argue that it is unlikely that a witness would be interviewed within the time frames generally used in the hypermnesia literature (i.e. 7 minute recall periods). They completed a study, again using a filmed crime, with varying retention periods (immediate recall then delayed recall after 3 weeks; immediate recall and then three recall tests at 1 week intervals; and delayed only recall, after three weeks). Rather than a time limited recall test, participants were
given approximately 20 minutes to recall what they had seen. It could be argued that this recall period would produce hypermnesia anyway given the results from Roediger and Thorpe (1978), however the findings did not support hypermnesia. What Turtle and Yuille did find was a reminiscence effect.

Turtle and Yuille (1994) argued that it was unreasonable to expect hypermnesia in the eyewitness domain, but that the finding of reminiscence was reliable and also more relevant to eyewitness situations. They described repeated testing retrieval in terms of a "sampling procedure in which a witness draws from a population of encoded details on each attempt" (p.268). This may help speed up the process on later trials allowing for new details to be remembered. At the same time some forgetting occurs. If witnesses can be helped to remember more details, even with some loss or forgetting, it must assist the investigative process.

Stress and Repeated Testing

Hypermnesia appears to be reliant on the use of pictures or high imagery words. The superiority of recall for pictures over words has been found in several studies (D'Agostino, O'Neill, & Paivio, 1977; Maisto & Queen, 1992; Nelson, Metzler & Reed, 1974; Purdy & Luepnitz, 1982; Standing, 1973). Paivio (1971) theorised that pictures and words are encoded under a dual coding system – pictures were encoded twice (both as an image and also as the verbal description or name of the item). This may explain why the findings of a hypermnesia effect for pictures and highly imaginable words are so well supported in the literature.

The possibility that words and pictures are encoded differently may have implications for the present study if this processing is affected differently by stress.
Markham and Darke (1991) found that highly test anxious participants performed more poorly on verbal reasoning tasks in comparison to spatial reasoning tasks. This finding was due to verbal reasoning tasks being affected by task irrelevant thinking in highly anxious participants. Markham and Darke suggested that task irrelevant thinking could be seen as a secondary verbal task. According to Paivio’s theory, pictures are encoded twice. Disruption of verbal encoding may be reversed by the lack of disruption for imagery materials. This may imply that visual or imagery tasks may be less susceptible to disruption by stress and may explain why high arousal often leads to better retention for eyewitness events (Christianson, 1992; Christianson & Hubinette, 1993; Yuille & Cutshall, 1986).

None of the studies reviewed so far have investigated the effect of stress on repeated recall. A recent study by Shaw, Bekerian, and McCubbin (1995), has looked at the influence of arousal on hypermnesia for imaginally encoded words. While hypermnesia is often found with pictures, it is also found when participants are instructed to use imagery when trying to learn the to be remembered words. Using either a nature film or a filmed sequence of violent events to induce arousal at varying stages during the memory process (prior to encoding, or before recall 1 or 2), they found hypermnesia only in the control condition and the condition which viewed the violent film at encoding. They concluded that only arousal which was induced during the retention interval has an inhibiting effect on hypermnesia because it affects post-stimulus elaboration (Christianson, 1992). The present study will investigate this finding using pictures and a crime scenario rather than words.
Stress in Eyewitness Memory

Some of the studies into eyewitness recall have used actual witnesses to a crime (Christianson & Hubinette, 1993; Kuehn, 1974; Tollestrup, Turtle & Yuille, 1994; Yuille & Cutshall, 1986). There appears to be some support for Christianson’s (1992) assertion that high arousal does not impair recall when real life witness situations are studied. When witness statements to crimes were compared to later interviews with the witness (Christianson & Hubinette, 1993; Yuille & Cutshall, 1986), those exposed to the highest level of arousal showed relatively accurate memory for event details they had previously given in statements. This suggests that stress may have a facilitative effect on recall, with little loss of memory over time when events are highly arousing. While in these studies comparisons could be made to prior witness statements, unless the exact details of the event are known, it is difficult to determine witness accuracy. For this reason it is essential to use the control available in a laboratory situation to determine the possible outcomes.

Other eyewitness studies have used staged crimes, either live (Hosch & Cooper, 1982); filmed (Clifford & Scott, 1978; Dunning & Stern, 1992; Scrivner & Safer, 1988; Turtle & Yuille, 1994) or slides (Christianson & Loftus, 1987; Christianson, Loftus, Hoffman & Loftus, 1991; Dobson & Markham, 1992; Eugenio, Buckhout, Kostes, & Ellison, 1982; Kramer, Buckhout, Fox, Widman, & Tusche, 1991; Siegel & Loftus, 1978), to examine the effects of stress on memory. One of the most criticised issues in the study of eyewitness recall is that the level of stress experienced in an eyewitness situation can not usually be manipulated in the laboratory. While this may be true, it is also not ethically sound to confront participants with a gun or place their lives in danger to measure the effects of their
stress. A couple of studies have used an innovative method to induce stress: the use of a syringe in a health setting (Maass & Kohnken, 1989; Peters, 1988). Peters (1988) measured eyewitness recall of a nurse who had inoculated participants at a health clinic, as well as recall of another nurse who had taken their pulse. Participants’ arousal was measured by physiological measures such as pulse rate and the completion of pencil and paper measures. Both descriptions and line-up identifications were poorer in the high arousal group, suggesting arousal has an inhibitory effect on memory.

In summary the studies on the effects of stress at encoding have shown poorer immediate recall followed by an improvement in delay (Kleinsmith & Kaplan, 1963, 1964; McLean, 1969; Parkin, Lewinsohn, & Folkhard, 1982) probably due to some inhibitory effect in early tests which strengthens the memory trace at delayed testing. Stress at the time of retrieval was also found to have a facilitatory effect on delayed recall by Uehling and Sprinkle (1968), however it had a disruptive effect if manipulated during the retention interval in the study by Shaw, Bekerian and McCubbin (1995). Accuracy is not generally found to be negatively affected by repeated testing (Dent & Stephenson, 1979; Dunning & Stern, 1992; Martin & Thomson, 1994; Scrivner & Safer, 1988; Turtle & Yuille, 1994).

The Present Study

Few studies have actually looked at the effect of stress on the retrieval stage of eyewitness memory. Dobson and Markham (1992) found that giving participants anxiety arousing instructions, in the form of evaluative threat at retrieval, resulted in improved accuracy of memory but there was no difference between high and low
anxious participants on a multiple choice test. The lack of a difference between high and low anxious participants may have been due to the difficulties in determining the level of arousal necessary to reach optimal performance. It is possible that separating participants into high and low arousal groups could also lead to a result of no difference, given the inverted U hypothesis (Yerkes-Dodson, 1908). Those who were given threat at both encoding and retrieval performed the best of all groups. This should not be surprising given the encoding specificity principle (Tulving & Thomson, 1973) which states that retrieval is dependent on how information was stored in the first place. In other words, those who were placed in the same condition at retrieval as they were when encoding the to-be-recalled information are in the optimal condition to retrieve what they have seen. The use of multiple tests here may produce the same effect for the groups in the same condition at both recalls, if the first recall is considered another instance of encoding (Tulving, 1964). Measuring the items that are recalled on both recall tests may provide also some measure of consistency, often seen as an indicator of a good witness (Dunning & Stern, 1992; Turtle & Yuille, 1994).

The findings that arousal at retrieval may lead to an improvement in performance are the basis for the present study, but with some differences to the studies already reviewed. This study investigated the nature of stress at differing times by using either immediate or delayed recall stress manipulations. Measuring participants in a stress/no stress within subject condition allowed within group comparisons to be made. While acknowledging Turtle and Yuille's (1994) argument that in an eyewitness situation it is unlikely that witnesses would be interviewed
Stress at Recall

within the timeframes used here, some indication of the direction of effects should be evident, giving a starting point for further investigation.

The purpose of the present research was to attempt to induce stress and measure its impact on the recall of participants. As was argued earlier, it is likely that at the retrieval stage of eyewitness memory, evaluative threat and time pressure are more representative of the stressors experienced by the eyewitness. At the same time, due to ethical considerations, the method used to induce stress needs to take into account any long-term effects. It was believed that combined time pressure and evaluative threat met these requirements, without any ongoing problems for participants. Although studies into the effects of stress often use physiological measures as well as subjective, there are difficulties with these measures. It was therefore decided that self reported measures of arousal were a sufficient indicator of participants’ stress.

For the purpose of this study, which focused only on the retrieval process, the stimulus materials were not used to induce a stress condition. How the participants came across or retained their memory for the experimental stimulus was not of interest or concern, only their response to stress at retrieval. The task of recalling visual stimuli such as pictures was considered more likely to represent processes used in witnessing an event. For this reason recall was tested first on pictures (line drawings taken from Snodgrass & Vanderwart, 1980), to determine the nature of stress on picture memory. Following on from this experiment, recall was tested for a handbag snatching incident in Experiment 2, to make this study more relevant to the eyewitness area.
The present study was concerned with the effects of stress on the number of items recalled at both immediate and delayed recall, repeated testing, and accuracy of recall. Based on the previous review, in examining the effects of stress it is possible there may be:

1. A negative effect of stress with lower recall and more errors in those participants in the stress at recall groups - explained in terms of task irrelevant thinking;

2. A positive effect of stress with higher recall and less errors by participants in the stress at recall groups due to the focusing of attention onto important details (Easterbrook, 1959);

3. That low or high stress might equally result in poorer memory for participants who have stress or no stress in both recall tests- Yerkes-Dodson inverted U (1908)

4. Better memory for those participants who have stress or no stress in both recall tests -upright U (Ebbeson & Konecni, 1997).

5. Based on the findings of several researchers (Kleinsmith & Kaplan, 1964, 1964; McLean, 1969; Parkin, Lewisohn, & Folkhard, 1982; Uehling & Sprinkle, 1968), an increase in the number of items recalled at the delayed recall test is also possible for those who have stress at immediate recall.
Chapter Two

Experiment 1

Method

Design. The design was a 2 (time of test: immediate and delayed) X 2 (stress at recall: immediate and delayed) with repeated measures, with time of test as a within subjects factor and stress at immediate or delayed being a between subjects factor.

Participants. Participants were 62 undergraduate psychology students (12 male, 50 female with a mean age of 26.42 years, range = 17 years to 56 years) from Edith Cowan University who volunteered after they were approached in their lectures and tutorial. Participants were run in groups of three to ten students. These groups were randomly assigned to one of four conditions: (a) NSNS (no stress at immediate recall and no stress at delayed recall; n = 16); (b) NSS (no stress at immediate recall and stress at delayed recall; n = 15); (c) SNS (stress at immediate recall and no stress at delayed recall; n = 16); and (d) SS (stress at both immediate and delayed recall; n = 15).

Materials. Materials for Experiment 1 consisted of 80 line drawings (see Appendix A for a list of items used), taken from Snodgrass and Vanderwart (1980). These pictures have been measured for name agreement, familiarity and frequency on a native English speaking, American population. Items which would be familiar to an Australian population were chosen. Participants were asked to record their first language and country of birth on the answer booklets so that any unusual answers could be verified. The pictures were shown by overhead projector, with five pictures to a sheet. A stopwatch was used to measure exposure times.
Procedure. Participants in groups of three to ten were assigned to one of the four conditions: NSNS, NSS, SNS, or SS. Assignment to all conditions was done by selecting a card from a deck of playing cards, with each suit of cards representing one of the experimental conditions.

After completing consent forms, participants were told that they were taking part in a memory experiment and to pay careful attention as they would be asked to recall items they had been shown. An initial set of 40 drawings (five per page) were shown at a rate of 20 seconds per sheet. At the end of this session, participants were asked to recall as many of the items as possible by naming or describing the items they had been shown. This allowed participants to become familiar with the procedure and work out any memory strategies.

The 40 target pictures followed the practice session and were also shown at the rate of 20 seconds per sheet of five drawings. After presentation, participants were told to try to recall as many items as they could. Up to this stage there was no difference in procedure between any of the groups. Two of the groups were now exposed to stress (SS & SNS). The stress manipulation consisted of: (a) Time pressure - a 3 minute recall period (determined in a pilot study) with time left to go updates every 30 seconds, followed by an update every 15 seconds during the last minute (at each of these updates importance of accuracy was stressed); (b) participants were told they were expected to fill every space on their answer sheet, which had 50 marked spaces (an unachievable number); and (c) the importance of accuracy of responses - which was stressed to participants as being linked to intelligence and academic ability. The no stress groups had no time limit to complete the task, and generally took between 4 and 5 minutes.

All groups then completed a filler task, which allowed a 20 minute delay. To incorporate the illusion that this task was related to academic performance the filler task was part of a standard intelligence test and required participants to draw, from
memory, geometric designs they had been shown. Other tasks involved completing analogy problems, and anagrams of Australian place names. The group which would not have a stress manipulation at the delayed recall (SNS) was reassured that they were no longer under pressure at this stage. They were told to relax and time pressure was no longer used.

After the filler task, participants were asked to think back to the target list and to again recall as many items as possible from that list only, this second recall test was unexpected. The delayed stress groups (SS & NSS) were exposed to the same stress procedure as described previously; the delayed no stress groups (SNS & NSNS) followed the same no stress procedure.

**Results**

Scoring was done by counting up the number of correct responses, change in scores from immediate recall to delayed recall, and the number of errors made. Although it was anticipated that some items may have been named differently by some participants from other countries, this was not the case. Participants also recorded their level of stress during each recall period on their answer booklets. Stress was measured on a scale of one to ten, with a score of one equating to fairly relaxed, while a score of ten equated to high stress levels. Unless reported otherwise, an alpha level of .05 was used in all statistical tests.

The study was interested in the effects of stress on the number of items recalled at each recall test, the effect of stress on repeated testing, and the influence of stress on error rates. The data was examined in relation to these questions, but first the success of the manipulation was determined.
Stress at Recall 28

Stress ratings. Mean self-reported stress ratings at immediate recall were analyzed using one-way ANOVA. Stress at immediate recall was found to differ significantly between the four groups, \( F(3,58) = 6.77, p = .001 \). Post hoc comparisons using Tamhane’s T2 for unequal variances showed that the no stress at immediate recall groups (NSNS & NSS) differed to the stress at immediate recall (SNS & SS) groups; the immediate stress groups having significantly higher reported stress.

Stress at delayed recall was analysed by a 2 (time of test) X 2 (stress at recall) ANOVA to determine whether stress at delay is influenced what has happened at immediate recall. There was a main effect of stress at delay, \( F(1,58) = 10.53, p = .002, \eta^2 = .154 \). The interaction was not significant, \( F(1,58) = 1.30, p = .26 \). Post hoc tests using Tamhane’s T2 for unequal variances showed that only the stress at immediate recall groups differed significantly at delay, with the SS groups having higher reported stress than the SNS group. Table 1 shows mean stress ratings for all groups, and Figure 1 shows the plotted means.

Table 1

<table>
<thead>
<tr>
<th>Condition</th>
<th>NSNS (n=16)</th>
<th>NSS (n=15)</th>
<th>SNS (n=16)</th>
<th>SS (n=15)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Immediate</td>
<td>4.00</td>
<td>2.31</td>
<td>4.27</td>
<td>2.34</td>
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<tr>
<td></td>
<td>6.53</td>
<td>2.46</td>
<td>6.67</td>
<td>1.30</td>
</tr>
<tr>
<td>Delayed</td>
<td>3.63</td>
<td>2.22</td>
<td>4.70</td>
<td>1.94</td>
</tr>
<tr>
<td></td>
<td>3.13</td>
<td>2.42</td>
<td>5.37</td>
<td>1.20</td>
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</table>
Recall. Scores for recall of items were analysed using a split plot analysis of variance (ANOVA), with manipulations of stress at recall as the between subjects factor and time of test as the within subjects factor. Assumptions of ANOVA were satisfactory.

Table E1 (Appendix E) shows the ANOVA results for recall scores. The ANOVA shows there were no differences between groups for recall, either at immediate or delayed recall. However there was a main effect of time of test $F(1,58) = 28.51$, $p = .000$, $\eta^2 = .33$, indicating that the scores from immediate to delayed recall changed significantly. There were also significant (within subject) interactions for time of test by delayed stress, $F(1,58) = 8.77$, $p = .004$, $\eta^2 = .13$; and time of test by immediate and delayed stress, $F(1,58) = 12.47$, $p = .001$, $\eta^2 = .18$. Post hoc comparisons using dependent $t$ tests were carried out using a Bonferroni adjusted alpha level of .0125 (Hills, 1997). The SNS group did not differ significantly from immediate to delayed recall, $t(15) = 1.38$, $p = .19$, and showed moderate...
Stress at Recall

Hypermnesia; however, the other three groups did differ between tests, their scores decreasing significantly at delay: NSNS, $t(14) = -4.66$, $p = .000$; NSS, $t(15) = -3.22$, $p = .006$; and SS, $t(14) = -3.85$, $p = .002$, showing forgetting. Table 2 shows mean recall scores at immediate and delayed recall for all participants. Figure 2 shows the plotted means for the stress at immediate recall groups.

Table 2

<table>
<thead>
<tr>
<th>Condition</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
<th>M</th>
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<tr>
<td>NSNS</td>
<td>18.75</td>
<td>5.60</td>
<td>21.00</td>
<td>4.68</td>
<td>18.69</td>
<td>4.90</td>
<td>19.60</td>
<td>5.34</td>
</tr>
<tr>
<td>NSS</td>
<td>21.00</td>
<td>4.68</td>
<td>18.69</td>
<td>4.90</td>
<td>19.60</td>
<td>5.34</td>
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<td>SNS</td>
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<td>Delayed</td>
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<td>NSNS</td>
<td>16.69</td>
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<td>19.38</td>
<td>4.90</td>
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<td>SS</td>
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</table>

Figure 2. Mean recall scores for both immediate and delayed recall for NSNS ($n=16$); NSS ($n=15$); SNS ($n=16$); and SS ($n=15$) groups.
Stress at Recall

Reminiscence scores were calculated by counting the total number of new items which were recalled at delayed recall by each participant. To determine whether the stress manipulation at immediate or delayed recall had differing effects on reminiscence, a 2 (time of test) X 2 (stress at recall) ANOVA was conducted on reminiscence scores. The ANOVA showed no main effects for stress at immediate recall conditions, $F(1,58) = 3.23, p = .08, \eta^2 = .05$; or for stress at delay conditions, $F(1,58) = 1.55, p = .22, \eta^2 = .03$; the interaction was not significant, $F(1,58) = 1.57, p = .22, \eta^2 = .03$. Mean reminiscence scores for the groups are shown in Table 3. The data for this analysis did not meet some of the assumptions of normality however, and as transformations did not improve normality the analysis was run untransformed (Tabachnick & Fidell, 1996). Results need to be interpreted with this in mind.

Table 3

<table>
<thead>
<tr>
<th>Mean Reminiscence Scores and Number of Items Recalled Twice</th>
<th>NSNS (n=16)</th>
<th>NSS (n=15)</th>
<th>SNS (n=16)</th>
<th>SS (n=15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Reminiscence</td>
<td>2.06</td>
<td>1.91</td>
<td>2.07</td>
<td>1.62</td>
</tr>
<tr>
<td>Items recalled both times</td>
<td>14.63</td>
<td>5.95</td>
<td>17.00</td>
<td>3.95</td>
</tr>
</tbody>
</table>

Scores for items which were recalled in both immediate and delayed tests were also obtained, in order to investigate any patterns emerging under stress. A 2 (time of test) X 2 (stress at recall) ANOVA showed no significant main effects or interaction: immediate stress, $F(1,58) = .33, p = .57, \eta^2 = .006$; delayed stress, $F(1,58) = .07, p = .8, \eta^2 = .00$; immediate by delayed stress, $F(1,58) = 2.27, p = .14, \eta^2 = .04$. Table 3 shows the mean number of items recalled at both immediate and delayed recall for the four groups.
Errors. The number of errors made during both recall tests were analysed using a split plot analysis of variance (ANOVA), with manipulations of stress at recall as the between subjects factor and time of test as the within subjects factor. The main effect for time of test was found to be significant $F(1,58) = 42.08, p = .000, \eta^2 = .42$, with all groups experiencing more errors at delayed recall. None of the interactions were statistically significant: time of test by immediate stress, $F(1,58) = .16, p = .70, \eta^2 = .003$; time of test by delayed stress, $F(1,58) = .19, p = .66, \eta^2 = .003$; time of test by immediate stress and by delayed stress, $F(1,58) = .07, p = .79, \eta^2 = .001$; stress had no effect on error rate. Some caution is also needed in interpreting these results however as some assumptions of normality were violated with this data set. Transformations of the data did not improve normality and therefore the data was left unaltered (Tabachnick & Fidell, 1996). Table 4 shows mean error scores for both recall tests.

Table 4

<table>
<thead>
<tr>
<th>Condition</th>
<th>NSNS (n=16)</th>
<th>NSS (n=15)</th>
<th>SNS (n=16)</th>
<th>SS (n=15)</th>
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<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Immediate</td>
<td>2.50</td>
<td>2.07</td>
<td>1.40</td>
<td>1.12</td>
</tr>
<tr>
<td>Delayed</td>
<td>6.00</td>
<td>4.13</td>
<td>4.73</td>
<td>5.16</td>
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</table>

Discussion

Experiment 1 investigated the effect of stress upon the retrieval stage of the memory process. The main findings of the study were that the number of items recalled at either immediate or delayed recall were not affected by the manipulation of stress. Reminiscence was found for all groups and this also was not affected adversely, or otherwise, by stress. While error rates increased significantly for all
groups between tests, there were no significant differences in errors between groups.

The Manipulation. Participants were asked to give self-report measures of their stress level, on a scale of one to ten. These ratings are shown in Table 1. At both immediate recall and delayed recall, the groups exposed to the stress manipulation had higher stress ratings than did the no stress groups, confirming the manipulation was successful. In debriefing, participants were asked whether they had felt under pressure and most reported that they had. The majority reported, however, that by the delayed recall test their stress levels had dropped somewhat, which may explain the lack of a significant increase in stress at delay for the NSS group.

Recall and Repeated Testing. The manipulation of stress at the time of retrieval does not seem to have had any apparent effects on the number of items recalled. There were no differences between groups at immediate or delayed recall. The pattern of recall for three of the groups (NSNS, NSS & SS) declined over time as would be predicted by Ebbinghaus' forgetting curve (1885/1964). However, as can be seen by Figure 2 the SNS group recall pattern increased slightly.

One explanation could be that because the manipulation involved time pressure, this group had a longer recall period during the delayed test (unlimited compared to three minutes in the stress condition) and this allowed them to recall more items. This is a possibility advanced by Turtle and Yuille (1994) who suggested that repeated retrieval involves a sampling procedure whereby details are retrieved from a population of encoded details. This may allow faster retrieval on later trials thereby allowing more time for new details to be retrieved.

Another possible explanation for the pattern of the SNS group is that they felt more relaxed during the second recall attempt and were able to recall slightly more items. This is supported by the decrease in their stress level between tests. Holmes
(1972) also found an effect of relaxation for both ego enhanced and ego threatened groups. Once groups had been debriefed, they were more able to redirect their attention to the task rather than being distracted by task irrelevant thinking.

**Context Effects**

Given the findings of Dobson and Markham (1992), of higher recall for the group which had arousal at both encoding and retrieval, it was anticipated that the groups which were placed in the same condition for both recalls (the NSNS and SS groups) may recall more of the same items on both recall tests than the other groups. The reinstatement of context has been found to useful in helping witnesses to retrieve memories of an event (Loftus & Doyle, 1992). It may be that context aids recall by allowing the person remembering to go back to the same starting point in memory yielding the same items on subsequent recalls.

Context effects have been studied by reinstating mood and drug induced states (Davies & Thomson, 1988), but not stress. Generally participants are placed in the same condition as when encoding the to be remembered information. In the present study, all participants were placed in an identical situation at encoding - if we are to consider the first recall as another instance of encoding (Tulving, 1964) then the SS and the NSNS conditions should benefit from their delayed recall conditions. As can be seen from Table 3, this was not the case and in fact the two groups placed in the same recall conditions at both tests performed worse than those who were not (although differences were non-significant). A higher number of items recalled on both tests, as compared to the groups who were placed in differing stress conditions at recall, would point to higher consistency of recall. If disruption or enhancement were to occur for the SS group it would show that context effects are susceptible to the impact of stress. The failure to obtain better performance for those in the same immediate and delayed recall conditions does not appear to be disrupted by stress.
however, as both the stress and no stress conditions performed equally.

Shaw, Bekerian and McCubbin (1995) found that arousal during the retention period was necessary for disruption of hypermnesia, but that during the encoding period it had no effect. The results here do not support the findings of Shaw et al. with regards to arousal during retention. Three of their conditions matched conditions in this study - the NSNS, NSS and SNS groups. They found hypermnesia only in the NSNS and arousal at encoding conditions in their study. Although not significant, there was a hypermnesic effect for their SNS group. They do not state cell sizes, however there were sixty participants and eight conditions, so it is assumed there were approximately eight in each cell. Perhaps the effect for their SNS group may have reached significance with a larger sample size.

The only group in the present study to show any hypermnesia effect, although modest, was the SNS group (mean increase = 0.56). The other groups all showed a decrease in scores or forgetting. Despite this finding, a reminiscence effect was found for all groups (there were no significant differences between groups). As Turtle and Yuille (1994) and Belmore (1981) have suggested, this should not be surprising. They contend that reminiscence is a more reliable finding than generally realised, possibly due to the fact that researchers do not measure for it. The finding is highly significant to the eyewitness situation because if witnesses tend to remember new details on each recall, even when highly aroused, this must be helpful to police investigations.

Accuracy. In all conditions, more errors were made on the second recall test than the first, but there were no significant differences between groups. This is consistent with Eugenio, Buckhout and Kostes (1982) who found a main effect for intrusions over trials. They suggested this may be due to participants who were being pushed to provide responses constructing details, particularly for participants they called “good witnesses” who were more accurate at immediate recall. While this is
one possible explanation, it does not explain why the NSNS group had the highest number of errors of all groups. If error rate is due to pressure, this group should have been more accurate, not less.

It is probable that the practice test conducted before the target list has contributed to the overall error rate here. Most of the errors were due to items being recalled from the practice list. With delay it may have been more difficult to distinguish on which list participants had seen items. While it is an important aspect of eyewitness recall to be able to identify where, and under what circumstances, a suspect has been seen (Deffenbacher, Brown & Sturgill, 1978), it may be that in this procedure the task became too difficult.

Conclusion

The manipulation of stress at retrieval does not appear to have had either an adverse or facilitatory effect on recall. Accuracy was also not significantly affected by stress, although the control group (NSNS) produced more errors than the other groups.

Contrary to Payne's (1987) assertion that "hypermnesia is the rule, rather than the exception" (p. 24), strong evidence for hypermnesia was not found here. This may be due to the shorter recall periods used. It does not appear that the lack of hypermnesia is due to the manipulation of stress, because the SNS group did reveal moderate hypermnesia. Despite the lack of hypermnesia there was a reminiscence effect for all groups, with new items recalled on the delayed test which were not recalled on the immediate test. This did not appear to be affected by stress, and this has implications for the eyewitness area. If witnesses can be helped to remember new details under repeated testing, even if some details are forgotten from previous attempts, this must be useful to the investigatory process. A more forensically relevant procedure was used in Experiment 2 to investigate these findings.
Method

Design. The design was a 2 (time of test: immediate and delayed) x 2 (stress at recall: immediate and delayed) with repeated measures, with time of test as a within subjects factor and stress at immediate or delayed being a between subjects factor.

Participants. Participants were 65 staff members from four metropolitan branches of a bank. This population was chosen because their occupation places them in the more likely position of being either a witness or victim of crime. Permission was sought beforehand from managers of each of the branches and the procedure incorporated a staff training session on bank security procedures. There were 8 males and 57 females with a mean age of 33.12 years (range = 17 years to 53 years). Staff were invited to participate and their taking part was purely voluntary. Groups were randomly assigned to one of the four experimental conditions: (a) NSNS (no stress at immediate recall and no stress at delayed recall; n = 16); (b) NSS (no stress at immediate recall and stress at delayed recall; n = 16); (c) SNS (stress at immediate recall and no stress at delayed recall; n = 17); and (d) SS (stress at both immediate and delayed recall; n = 16).

Materials. A series of 12 slides depicting a handbag snatching scenario were the stimulus materials (see Appendix B for a brief description of the slides). Each
slide was judged beforehand by six independent judges for the most salient features of each picture. These judgements were used as a benchmark for scoring recall. Responses were recorded on a sheet with several headings relating to the offender, victim and the sequence of events (see Appendix C). The slides were shown using a Kodak Carousel S slide projector onto a projection screen.

Procedure. Participants completed consent forms. Then they were advised that they would be shown a slide sequence about which they would be asked to recall details. They were informed that the slides involved the re-enactment of a crime and if anybody felt that they would find this disturbing they were free to leave; nobody withdrew from the experiment. Participants were assigned into the same four groups as Experiment 1 (NSNS, NSS, SNS, & SS) by the same procedure. The slides were shown at the rate of 5 seconds per slide. After presentation participants were asked to recall as much information as possible about the events they had just seen.

The immediate stress groups were exposed to stress at this stage: (a) Time pressure, (b) importance of accuracy and (c) information regarding the number of possible responses. The manipulation of a link to academic ability was not used with this population as it was not expected to have the same effect as on a student population. Time pressure was manipulated by allowing the stress groups (SS & SNS) only 4.5 minutes to complete the descriptions (recall periods were determined in a pilot study). Again time left to run was announced every 30 seconds after 1 minute and every 15 seconds in the last minute; importance of accuracy was stressed throughout. Participants were told the number of possible responses as determined by
the independent judges (43 in total). The no stress groups (NSS & NSNS) had as much time as they liked to complete the task, and usually took about 6 minutes.

Rather than the filler task from Experiment 1, a training session on branch security formed the delay period of 20 minutes. The delayed no stress group (SNS) were instructed to relax and were reassured that they were no longer under any pressure during this time. After 20 minutes the participants were again asked to recall the slide sequence, this recall test was unexpected. The same stress / no stress procedures were used as before. Participants recorded a self-report measure of stress for both the immediate and delayed recall tests. Stress was measured on a scale of one to ten, with a score of one meaning fairly relaxed and a score of ten meaning highly stressed.

Results

The information obtained by the six independent judges identified 17 items about the offender, 7 items about the victim and 19 items to do with the sequence of events, that were considered salient (see Appendix D for the scoring protocol). When scoring responses it was noted that many of the participants recalled more than the initial items, and what was recalled in some cases would be relevant in trying to locate and identify the offender. These additional responses were also included in the scoring protocol. There were 19 items about the offender, 13 items about the victim, and 23 items about the sequence of events, giving a total of 55 items in all that could be recalled. Using the same procedure as Turtle and Yuille (1994), in some cases where details were incomplete (e.g. one number or letter wrong in the number plate) the answer was scored as correct; if only half the number plate was given then the
score given was half a point. Errors were scored if an answer was given which would be misleading (e.g. hair colour of the offender given as black when it was light brown). In some cases, assumptions were made that the car used to get away was being stolen from the victim. Although this was not the case, it was reasonable to assume from the amount of detail given in the slides that this might be the case; these types of answers were not scored as errors. Two people scored the answer sheets, the experimenter and an independent rater who was blind to the experimental conditions. An inter-rater reliability of 97.67% was obtained.

As in Experiment 1 data were analysed in relation to the effect of stress on the number of items recalled, repeated testing and error rates. Likewise, as in Experiment 1, the strength of the stress manipulation was examined first.

**Stress ratings.** Participants were asked to record their stress level on their answer sheets. Mean self-reported stress ratings at immediate recall were analysed using one-way ANOVA. Stress at immediate recall was not found to differ significantly between the four groups $F(3, 61) = 1.68, p = .18$.

Stress at delayed recall was analysed using a 2 (time of test) X 2 (stress at recall) to determine whether alterations in stress levels were dependent on what had happened in the first recall test. Delayed stress did differ significantly, $F(1, 61) = 21.20, p = .000, \eta^2 = .258$; and the interaction of immediate and delayed stress was also significant, $F(1, 61) = 8.20, p = .006, \eta^2 = .12$. Post hoc comparisons using Tamhane's T2 for unequal variances showed that stress ratings for the SNS group were significantly lower than for the stress at delay groups (SS & NSS), but did not
differ from the NSNS group. Table 5 shows stress ratings at immediate and delayed recall, and Figure 3 shows the plotted means.

Table 5

<table>
<thead>
<tr>
<th>Condition</th>
<th>NSNS (n=16)</th>
<th>NSS (n=16)</th>
<th>SNS (n=17)</th>
<th>SS (n=16)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Immediate</td>
<td>3.50</td>
<td>2.50</td>
<td>4.00</td>
<td>2.28</td>
</tr>
<tr>
<td>Delayed</td>
<td>3.38</td>
<td>2.09</td>
<td>4.06</td>
<td>1.65</td>
</tr>
</tbody>
</table>

Figure 3. Mean stress ratings at immediate and delayed recall for NSNS (n=16), NSS (n=16), SNS (n=17), and SS (n=16).
Recall. Scores for immediate and delayed recall of the slide sequence were analysed using a split plot ANOVA, with manipulations of stress at recall as the between subjects factor and time of test as the within subjects factor. Assumptions of ANOVA were satisfactory. Table E2 (refer Appendix E) shows the ANOVA results for recall scores. There was a significant between subjects interaction for immediate and delayed recall scores, $F(1,61) = 3.98, p = .05, \eta^2 = .06$. The within subjects main effect for time of test, $F(1,61) = 11.07, p = .001, \eta^2 = .15$; and interaction for time by immediate stress, $F(1,61) = 17.70, p = .000, \eta^2 = .23$, were also significant. Post hoc tests using dependent $t$ tests and an adjusted Bonferroni alpha level of $.0125$ (Hills, 1997), indicated that the groups with stress at immediate recall differed significantly between their first and second recall tests: SNS, $t(16) = 3.06, p = .007$; SS, $t(15) = 4.77, p = .000$, producing hypermnesia. The groups with no stress at immediate recall did not differ between recall tests: NSNS, $t(15) = -.63, p = .54$; NSS, $t(15) = -.254, p = .80$. Table 6 shows mean recall scores at immediate and delayed recall for all participants, and Figure 4 shows the plotted means for participants' recall scores by immediate stress condition.

Table 6

Mean Scores for Immediate and Delayed Recall

<table>
<thead>
<tr>
<th>Condition</th>
<th>NSNS (n=16)</th>
<th>NSS (n=16)</th>
<th>SNS (n=17)</th>
<th>SS (n=16)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Immediate</td>
<td>25.75</td>
<td>4.93</td>
<td>23.00</td>
<td>3.75</td>
</tr>
<tr>
<td>Delayed</td>
<td>25.34</td>
<td>5.54</td>
<td>22.88</td>
<td>3.70</td>
</tr>
</tbody>
</table>
Figure 4. Mean recall scores for both immediate and delayed recall for NSNS (n=16), NSS (n=16), SNS (n=17), and SS (n=16) groups.

Reminiscence (gross change) was scored by counting the number of items recalled at delayed recall which were not recalled at immediate recall, for each participant. Table 7 shows mean reminiscence scores for each group. A 2 (time of test) x 2 (stress at recall) ANOVA showed there was a main effect of immediate stress, $F(1,61) = 11.72, p = .001, \eta^2 = .16$, with groups experiencing stress at immediate recall (SS & SNS) having higher reminiscence than the no stress at immediate groups (NSNS & NSS). Neither the main effect of delayed stress, $F(1,61) = .03, p = .87, \eta^2 = .000$; nor the interaction of immediate and delayed stress, $F(1,61) = .03, p = .87, \eta^2 = .000$, were statistically significant. There were problems with normality with this data set however, so results need to be interpreted cautiously.
Transformations did not improve the normality so the analysis was run unchanged (Tabachnick & Fidell, 1996).

Scores for items which were recalled in both immediate and delayed tests were also obtained, in order to investigate any patterns emerging under stress. A 2 (time of test) X 2 (stress at recall) ANOVA showed no significant main effects: immediate stress $F(1,61) = .29, p = .59, \eta^2 = .005$; delayed stress $F(1,61) = .004, p = .95, \eta^2 = .000$; or interaction $F(1,61) = .3.01, p = .09, \eta^2 = .05$. Table 7 shows the mean number of items recalled at both immediate and delayed recall for the four groups.

Table 7

Mean Reminiscence Scores and Number of Items Recalled Twice

<table>
<thead>
<tr>
<th>Condition</th>
<th>NSNS (n=16)</th>
<th>NSS (n=16)</th>
<th>SNS (n=17)</th>
<th>SS (n=16)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Reminiscence</td>
<td>2.09</td>
<td>1.37</td>
<td>2.09</td>
<td>0.86</td>
</tr>
<tr>
<td>Items recalled</td>
<td>23.75</td>
<td>5.09</td>
<td>21.88</td>
<td>4.84</td>
</tr>
<tr>
<td>both times</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Errors. Total error scores were analysed using a split plot analysis of variance (ANOVA), with manipulations of stress at recall as the between subjects factor and time of test as the within subjects factor. Table E3 shows mean error scores for both immediate and recall tests (see Appendix E). Neither between subjects main effects nor interactions were significant: immediate stress, $F(1,61) = .11, p = .74, \eta^2 = .002$; delayed stress, $F(1,61) = 2.40, p = .13, \eta^2 = .04$; and immediate by delayed
interaction, $F(1, 61) = 1.85, p = .18, \eta^2 = .03$. For within subjects there were no significant main effects or interactions: time of test, $F(1, 61) = .15, p = .7, \eta^2 = .003$; time by immediate stress, $F(1, 61) = 1.38, p = .25, \eta^2 = .02$; time by delayed stress, $F(1, 61) = .83, p = .37, \eta^2 = .013$; and time by immediate by delayed stress, $F(1, 61) = .02, p = .9, \eta^2 = .000$, indicating that stress did not affect accuracy.

The number of errors made during both recall tests were separated into errors about the offender, the victim and the scenario to determine whether stress had an effect on different aspects of the slide sequence. Separate analyses for offender, victim and scenario were conducted using one-way chi-square, to determine whether any group made more errors under stress. Results show that for delayed recall, errors regarding the offender differed significantly between the four groups: $\chi^2(3, N = 50), p < .05$, with the SS group making significantly less errors than the other groups. All other analyses were non-significant. The expected frequency assumptions of chi-square were not met for errors about scenario, however the error rate was negligible for all groups making this analysis unimportant. Table 8 shows chi-square results for the remaining analyses. See Appendix F for chi-square calculations (Hills, 1994).
Table 8

Proportion of Errors by Group for Offender, Victim and Scenario

<table>
<thead>
<tr>
<th></th>
<th>NSNS</th>
<th>NSS</th>
<th>SNS</th>
<th>SS</th>
<th>Total Errors</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immediate</td>
<td>30.35</td>
<td>25.00</td>
<td>30.35</td>
<td>14.28</td>
<td>56</td>
<td>n.s.</td>
</tr>
<tr>
<td>Delayed</td>
<td>28.00</td>
<td>24.00</td>
<td>18.00</td>
<td>10.00</td>
<td>50</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Victim</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immediate</td>
<td>16.92</td>
<td>24.61</td>
<td>35.38</td>
<td>23.07</td>
<td>65</td>
<td>n.s.</td>
</tr>
<tr>
<td>Delayed</td>
<td>25.33</td>
<td>25.33</td>
<td>28.00</td>
<td>21.33</td>
<td>75</td>
<td>n.s.</td>
</tr>
<tr>
<td>Scenario</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immediate</td>
<td>32.00</td>
<td>24.00</td>
<td>20.00</td>
<td>24.00</td>
<td>12.5</td>
<td>n.s.</td>
</tr>
<tr>
<td>Delayed</td>
<td>34.78</td>
<td>26.09</td>
<td>21.74</td>
<td>17.39</td>
<td>11.5</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

Discussion

Experiment 2 investigated the effect of stress upon the retrieval stage of the eyewitness memory process. The main findings of this study were that the number of items recalled at delayed recall increased significantly for the groups with stress at immediate recall. All groups demonstrated reminiscence, however this was greater for the stress at immediate recall groups. There were no differences in overall error rates.

The Manipulation. As with Experiment 1, participants were asked to give self-report measures, on a scale of one to ten, of their stress level. Table 5 shows these self ratings. It appears that the manipulation has not been as successful as for Experiment 1. At immediate recall the SNS group has lower stress than the NSS group. While the drop in delayed stress for the SNS group is as anticipated, the
immediate stress manipulation has not had the desired effect. The NSNS and SS groups remained reasonably stable as expected, with the SS having higher stress levels than the NSNS group. It appears that the same difficulties of manipulating delayed stress in the NSS group were evident here.

It would seem that the use of evaluative threat and time pressure does not have the same effect on bank officers as university students. This is probably due to the students feeling more anxious about the possible link to academic ability (particularly as they were first year students). While the importance of accuracy was stressed to the bank staff, it was not possible to link it to any personal failure and therefore time pressure was the main stressor. Future research would need to carefully consider the stress manipulation as to the relevance it may have to participants.

**Recall and Repeated Testing.** The same pattern of results which was found in Experiment 1 was not found in Experiment 2. At delayed recall, the groups which had stress at immediate recall (SS and SNS) differed from the groups who had no stress at immediate recall (NSNS and NSS). This suggests that what happened in the first recall period had an effect on what happened in the delayed recall period, regardless of the stress manipulation at delay.

The results tend to support the findings of Uehling and Sprinkle (1968) who found that white noise at retrieval had a facilitatory effect on delayed recall but not on immediate recall. They suggested that immediate performance may have already been at a peak but with delay, forgetting had occurred and arousal had facilitative effects on retention. Uehling and Sprinkle still had some forgetting however, and in the
present study there is actually an increase in recall over time, for those with immediate stress.

Kleinsmith and Kaplan (1963, 1964) found an increase in the number of items recalled in delayed recall (reminiscence) for high arousal items, but the opposite for low arousal items. They explained their results for high arousal in terms of reverberating neural circuits, which left neural traces unavailable at immediate recall but consolidated items in memory for later recall. The results here do not replicate Kleinsmith and Kaplan's findings at immediate recall however. This is perhaps due to the differences in methodology, with Kleinsmith and Kaplan using paired associates (words) and arousal at encoding, whereas the present study used free recall of slides with arousal at retrieval.

What is of interest, is the increase of recall at delay when stress has been manipulated at immediate recall. It is possible that stress at immediate recall allows attentional focus to narrow so that only important details are remembered. This is the basis of Easterbrook's cue utilisation theory (1959). This narrowing of focus may facilitate performance regardless of the stress condition at later recall, and may be enhanced by rehearsal or thinking about how one might have performed better, allowing new items to be recalled.

One problem with explaining the results in terms of stress at immediate recall is that there were no differences between reported stress levels at immediate recall. It may not be that it is the level of stress which has a facilitative effect but rather the use of time pressure. Time pressure may have assisted the retrieval process so that items at immediate recall were recalled more quickly, and later recall was enhanced because of this speeded process. This is borne out by both the reminiscence and
Stress at Recall 49

hypermnesia scores. The groups exposed to stress at immediate recall showed both hypermnesia and higher reminiscence scores than the groups with no stress at immediate recall. Alternatively, it may be that the self-report measures of stress were not consistent with the level of stress participants were experiencing. In either case, despite the reported stress ratings it appears the stress manipulation had an effect on recall.

In contrast to Experiment 1, the findings for items recalled twice, or context effects, were the opposite for Experiment 2. The SS and NSNS groups recalled more items on both recalls than the other groups, although again the effect was non-significant. This is more consistent with Ebbeson and Konecni’s (1997) view of the Yerkes-Dodson curve with the U upright instead of inverted - in this case the high and low stress groups (SS & NSNS respectively) performing better than the other groups.

As in Experiment 1 the results did not support those found by Shaw, Bekerian an McCubbin (1995), which casts some doubt on their results. They did not have a SS condition so comparisons for this group are not possible, but the SNS group in the present study again produced hypermnesia. Combined with the hypermnesia effect for the SS group, this may suggest that stress does not have a disruptive effect on hypermnesia if it occurs before the first recall. This supports Payne’s (1987) suggestion that factors in earlier tests assist performance in later tests. It also may shed some light on the question of when, during post-stimulus elaboration, arousal interferes with hypermnesia.

As pointed out in the discussion on Experiment 1, Shaw et al. (1995) did obtain non-significant hypermnesia in their SNS group, suggesting that with a larger
sample this may have reached significance. Their NSS group scored the same over both recalls, a similar result to the present study. This would seem to suggest that stress before the second recall period disrupts hypermnesia but that stress that occurs before the first recall has a facilitative effect.

Reminiscence was found again for all groups with significantly higher reminiscence for the participants with stress at immediate recall than with no stress at immediate recall, again indicating a facilitative effect of early stress. This suggests that highly stressed witnesses may be able to improve their testimony with further recall tests.

Accuracy. There were no main effects or interactions for error rates. There was no significant increase in errors across recall trials as was the case in Experiment 1. This finding is more consistent with findings by several researchers of hypermnesia in the eyewitness area who have found that a hypermnesia or reminiscence effect (for free recall) does not come with a reduction in accuracy (Dent & Stephenson, 1979; Dunning & Stern, 1992; Scrivner & Safer, 1988; Turtle & Yuille, 1994).

Separate analyses of the errors for offender, victim and scenario showed differences between groups for the delayed recall of offender; the SS group being more accurate than the other groups. This is possibly explained by participants in this condition recalling to criterion, prohibiting them from giving answers they were unsure of. This should also be reflected in their recall scores with fewer details reported due to greater caution, however this was not the case. Another explanation could be that these participants narrowed their focus under stress so that they primarily attended to and rehearsed important or central details (Easterbrook, 1959).
Details about the offender would be the most important to a police investigation and the SS group was the most accurate of all groups for details about the offender. Despite the higher reminiscence also found for the SNS group, their error rate was much higher - particularly at delayed recall suggesting that once the pressure was off they became more error prone, possibly even guessing. The findings by Leon and Revelle (1985) of a speed accuracy trade-off were not supported here, perhaps due to the differences in methodology - they used an analogical reasoning task rather than recall, and reaction times were measured in their study, but not here.

Conclusion

The results from Experiment 2 show that stress has had an effect on recall scores. Results indicate it appears to have a facilitatory effect if it occurs before the first recall test, but not the second. This facilitation may occur because of enhanced focus when participants recall under pressure at immediate recall, allowing items to be more easily retrieved on later tests.

The hypermnesia effect was stronger in Experiment 2 suggesting that perhaps the more meaningful slide sequence assisted net increases in recall. Eugenio et al. (1982), pointed to possible motives that participants might place on the characters in the witnessed scenario, as a potential explanation. Undoubtedly, most people have some sort of schema for a handbag snatch and it may just be that participants here were recalling that schema. This was certainly true for some participants who believed that the offender was stealing the victim's car. However the error rate for recall of the scenario was the lowest for all groups, it does not seem likely that participants were guessing.
Again reminiscence was found for all groups suggesting it is not susceptible to stress. It is maintained here that reminiscence is more important than hypermnesia in eyewitness recall. Any improvement in the number of items recalled must be beneficial to the investigatory process, despite the general opinion of police and the courts that loss of some items while recalling new ones makes for an unreliable witness (Turtle & Yuille, 1994).
Chapter Four

General Discussion

Methodological Issues

In comparing the two experiments there are some methodological differences which may have contributed to some of the disparate findings. Firstly the manipulation of stress was more successful with the student participants in this study, evidenced by their higher reported stress ratings. The use of evaluative threat on participants other than a student population may need to take into consideration what is personally relevant to the participants as an evaluative threat. A higher stress level was also possibly maintained by the filler task in Experiment 1, which involved analogy problems, anagrams and copying geometric designs from memory. This sustained the illusion of the link to academic ability. In contrast, the training session on bank security was possibly more relaxing for the bank officers. The task was more passive and may even have allowed participants to review the slides in their minds during the delay period. While this is a possibility, the ability to review or think about the observed event is not necessary for a hypermnnesia or reminiscence effect (Payne, 1987; Turtle & Yuille, 1994).

It may also be that the stronger evaluative threat in Experiment 1 led to task irrelevant thinking for those participants causing the poorer SS performance; whereas in Experiment 2 stress allowed attention to focus, producing an improvement in performance for the SS group. This would incorporate both aspects of cue utilisation – as a reduced cue function and also an enhanced cue function. It may also allow the
results to be plotted on the Yerkes-Dodson curve (1908), the task in Experiment 1 being considered more difficult and having higher related stress.

The task itself was also perhaps more difficult for the student participants than the bank staff participants. The practice test beforehand led to greater error rates in Experiment 1, however these errors were related to items on the practice test. It is possible, that without the practice test, the error rate would have been negligible, there were few real errors. The difficulty is in determining how difficult the eyewitness task is in relation to situations manipulated in a laboratory. It may be that despite the differences to an actual eyewitness event, that Experiment 1 was more representative of the difficulty of the task. The need to identify when and where a witness has seen an event is an important factor in eyewitness memory, it may be necessary to include this type of distractor in future studies to try to replicate this element. Eyewitness situations do not happen in isolation of other perceptual cues, details leading up to and after the event may be confused in the mind of the witness. For this reason, Experiment 2 may have attained more face validity if it had included a practice element.

Another factor which may have made the handbag snatch slide sequence more easy to recall was the length of time items to be remembered were observed. In Experiment 1 each picture was seen for an average of 4 seconds (5 per slide at the rate of 20 seconds per slide). On the other hand, for the slide sequence, although shown for approximately the same length of time, many of the to be remembered items were seen in several of the slides. This may have allowed participants to rehearse items more easily. Another factor is that this task had a storyline, in
comparison to the picture task, and this may have assisted participants in recalling the sequence of events.

**Limitations of the Present Study**

Although the present study has not overcome many of the criticisms leveled at eyewitness research - such as laboratory studies versus field studies (Ebbeson & Konecni, 1997; Yuille & Tollesstrup, 1992); realistic levels of stress (Yuille & Tollesstrup, 1992); retention periods (Turtle & Yuille, 1994); and realism of the stimulus (Yuille & Cutshall, 1986) - it presents a previously unresearched area - the effects of stress on reminiscence. Furthermore, as Ebbeson and Konecni (1997) point out, the same memory processes involved in witnessing a crime may still apply here. Researchers can only know about memory by studying memory, and this involves studying memory using all types of settings and manipulations.

To this end, further research might look at the effects of varying retention intervals, both for the first and second recall, to determine the effects of stress over a more realistic timeframe. It might also be useful to incorporate a stress at encoding manipulation, perhaps involving a threat of harm, to replicate the full range of eyewitness arousal experienced. The stress manipulation needs further consideration if using participants other than university students, although this should not prohibit the use of participants from outside the academic population. This study has demonstrated the dissimilarity of students to bank officers in regard to evaluative threat. This finding points to the need to use other populations in order to improve the generalisability of research.
One further recommendation is the inclusion of a recognition test, perhaps in the form of a line-up or photo spread. Turtle and Yuille (1994) suggested that repeated testing may lead to mis-identification in line-ups if the offender has changed appearance and the participants have rehearsed a particular image of the offender. This could of course happen with or without repeated testing, however it has relevance to the knowledge base about eyewitness memory. Thomson and his colleagues (Thomson, Robertson & Vogt, 1982) have conducted extensive investigations into the nature of context on memory. The effects of stress would add further to this body of knowledge.

Implications of the Study

In both studies a reminiscence effect was found for all groups, and this was not diminished by participants’ stress levels. The SNS group in both studies produced the highest level of reminiscence, however in Experiment 2 this level was matched by the SS group. It appears that stress at immediate recall increases the level of retrieval of new items at later recall. The findings in Experiment 2 more closely reflect those of Kleinsmith and Kaplan (1963, 1964) of poorer immediate recall and better delayed recall for high arousal items.

Heuer and Reisberg (1992) suggested that two principles were implicated in the poor immediate and better delayed performance results often found with multiple testing of emotionally arousing events: (a) a slowing of forgetting; and (b) a narrowed but also enhanced attentional focus. Slowed forgetting is affected by: (a) physiological arousal activating both biological and neurological mechanisms in the brain; (b) the distinctiveness of more emotional events; and (c) extra attention and
rehearsal given to these events. These three elements interact and none of them explain the effect in isolation. Narrowed attention is the basis of Easterbrook’s (1959) cue utilisation theory and Heuer and Reisberg, as well as Christianson (1992), suggest that narrowed focus in combination with post event elaboration or rehearsal, strengthen the memory for highly arousing situations. It is likely that when faced with a recall test, as with emotionally arousing situations, participants go over the test in their minds after the event. It is this post event rehearsal that leads to slowed forgetting and possibly enhanced retrieval processes on later tests.

This research has demonstrated that stress at the retrieval stage of memory does not have a decremental effect on memory performance. In fact when combined with multiple tests it has a facilitative effect by increasing the potential for extra items to be recalled. The findings here further support Turtle and Yuille’s (1994) argument that “gaining and losing details on successive recalls is typical of how memory works” (p. 269). If this is the nature of memory, even under stress, it is important that those involved in taking witness statements are aware of this factor and use it to their best advantage in investigating crimes.
References


Appendix A

Table A1

**Items Used in Practice Recall List**

<table>
<thead>
<tr>
<th>apple</th>
<th>clown</th>
<th>foot</th>
<th>mushroom</th>
<th>snake</th>
</tr>
</thead>
<tbody>
<tr>
<td>axe</td>
<td>comb</td>
<td>football</td>
<td>rocking chair</td>
<td>train</td>
</tr>
<tr>
<td>balloon</td>
<td>cow</td>
<td>giraffe</td>
<td>ruler</td>
<td>turtle</td>
</tr>
<tr>
<td>bicycle</td>
<td>desk</td>
<td>grapes</td>
<td>saw</td>
<td>violin</td>
</tr>
<tr>
<td>cake</td>
<td>dress</td>
<td>heart</td>
<td>scissors</td>
<td>watch</td>
</tr>
<tr>
<td>camel</td>
<td>ear</td>
<td>iron</td>
<td>screwdriver</td>
<td>well</td>
</tr>
<tr>
<td>car</td>
<td>envelope</td>
<td>lamp</td>
<td>shoe</td>
<td>whistle</td>
</tr>
<tr>
<td>chain</td>
<td>flag</td>
<td>monkey</td>
<td>sail</td>
<td>window</td>
</tr>
</tbody>
</table>

**Note.** Items are listed alphabetically, items were presented in a format which was mixed, both for categories and alphabetical order.

Table A2

**Items used in target recall list**

<table>
<thead>
<tr>
<th>banana</th>
<th>chair</th>
<th>gun</th>
<th>nose</th>
<th>star</th>
</tr>
</thead>
<tbody>
<tr>
<td>bed</td>
<td>clock</td>
<td>hammer</td>
<td>piano</td>
<td>telephone</td>
</tr>
<tr>
<td>book</td>
<td>dog</td>
<td>helicopter</td>
<td>pineapple</td>
<td>television</td>
</tr>
<tr>
<td>bus</td>
<td>door</td>
<td>horse</td>
<td>rabbit</td>
<td>thumb</td>
</tr>
<tr>
<td>butterfly</td>
<td>elephant</td>
<td>kangaroo</td>
<td>sandwich</td>
<td>tree</td>
</tr>
<tr>
<td>candle</td>
<td>eye</td>
<td>key</td>
<td>shirt</td>
<td>umbrella</td>
</tr>
<tr>
<td>carrot</td>
<td>fish</td>
<td>kite</td>
<td>skirt</td>
<td>windmill</td>
</tr>
<tr>
<td>cat</td>
<td>guitar</td>
<td>m...orecycle</td>
<td>snowman</td>
<td>zebra</td>
</tr>
</tbody>
</table>

**Note.** Items are listed alphabetically, items were presented in a format which was mixed, both for categories and alphabetical order.
Dear Participant,

This study is being conducted as part of my Honours degree at Edith Cowan University. The purpose of the study is to investigate the relationship between memory and academic performance. You will be asked to recall items you have been shown; you may be asked to complete the task under test conditions.

Your participation is voluntary, and if you agree to participate you are able to withdraw at any time during the procedure. The information obtained is totally anonymous, and you will not be required to give any information which will identify you.

The information obtained from this research will be of use to academic staff in structuring courses. If you wish to find out the results of the study, please feel free to write to me requesting a summary.

Should you have any queries regarding this project please feel free to contact me, or my University supervisor at the address below.

Yours sincerely,

Mary-Anne Martin
Ph 9451 3325

Supervisor
Professor Don Thomson
School of Psychology
Edith Cowan University
Joondalup Campus
Ph 9400 5626

I (the participant) have read the information above and any questions I have asked have been answered to my satisfaction. I agree to participate in this activity, realising I may withdraw at any time.

I agree that the research data gathered for this study may be published provided I am not identifiable.

Name.............................................................................. Date...........................

Signature.............................................................................
### Description of slide sequence

<table>
<thead>
<tr>
<th>Slide No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A group of people are standing outside a building talking to each other. There are three females and one male.</td>
</tr>
<tr>
<td>2</td>
<td>One of the women leaves the group and walks away.</td>
</tr>
<tr>
<td>3</td>
<td>The offender appears and walks towards the woman.</td>
</tr>
<tr>
<td>4</td>
<td>He appears to ask her a question.</td>
</tr>
<tr>
<td>5</td>
<td>He makes a snatch for her bag, raising his right fist as if to hit her, they struggle over the bag.</td>
</tr>
<tr>
<td>6</td>
<td>Close up shot of offender with fist raised.</td>
</tr>
<tr>
<td>7</td>
<td>Continue to struggle.</td>
</tr>
<tr>
<td>8</td>
<td>Offender has knocked woman to ground and has taken bag from her. He is running off with the bag.</td>
</tr>
<tr>
<td>9</td>
<td>The two female friends try to help the victim, the male friend chases after offender.</td>
</tr>
<tr>
<td>10</td>
<td>Offender looks at contents of bag.</td>
</tr>
<tr>
<td>11</td>
<td>Shot of offender opening a white car.</td>
</tr>
<tr>
<td>12</td>
<td>Back view of car showing number plate and location in a disabled parking bay.</td>
</tr>
</tbody>
</table>
Appendix C

Please tell me everything you can remember about the offender.
Height .................................................................
Build ......................................................................
Hair........................................................................
Colouring ..........................................................
Age ........................................................................
Clothes ....................................................................
.............................................................................
.............................................................................
Other ........................................................................
.............................................................................

Please tell me everything you can remember about the victim.
Height .................................................................
Build ......................................................................
Hair / Colouring ........................................................
Clothes .....................................................................
.............................................................................
Other ........................................................................
.............................................................................

Please tell me everything you can remember about the actual slide sequence, i.e. what happened.
.............................................................................
.............................................................................
.............................................................................
.............................................................................
.............................................................................
.............................................................................
.............................................................................

A G S
### Appendix D

#### Scoring protocol

<table>
<thead>
<tr>
<th>Offender</th>
<th>Judges</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td>Male</td>
</tr>
<tr>
<td><strong>Height</strong></td>
<td>Tall / &gt; 5ft 10 ins / &gt; 178cm</td>
</tr>
<tr>
<td><strong>Build</strong></td>
<td>strong / medium</td>
</tr>
<tr>
<td><strong>Hair</strong></td>
<td>blonde / fair / brown (light)</td>
</tr>
<tr>
<td></td>
<td>- long / shoulder length / straggly</td>
</tr>
<tr>
<td><strong>Colouring</strong></td>
<td>fair / white / caucasian</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td>25 to 35 years</td>
</tr>
<tr>
<td><strong>Clothes</strong></td>
<td>Flannel shirt / overshirt / jacket</td>
</tr>
<tr>
<td></td>
<td>- blue / purple and yellow / green check</td>
</tr>
<tr>
<td></td>
<td>- black / navy tshirt</td>
</tr>
<tr>
<td></td>
<td>- picasso print / split face</td>
</tr>
<tr>
<td></td>
<td>- motif</td>
</tr>
<tr>
<td></td>
<td>pale blue / light / faded jeans</td>
</tr>
<tr>
<td></td>
<td>tan / brown boots / workboots</td>
</tr>
<tr>
<td>*</td>
<td>leather thong fish pendant</td>
</tr>
<tr>
<td></td>
<td>black / navy beanie</td>
</tr>
<tr>
<td></td>
<td>- logo / motif</td>
</tr>
<tr>
<td></td>
<td>- 3 waves / sss / Westsuits logo</td>
</tr>
<tr>
<td></td>
<td>eyes - green / hazel</td>
</tr>
</tbody>
</table>

#### Victim

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td>Female</td>
</tr>
<tr>
<td><strong>Height</strong></td>
<td>Short / small / &lt; 5ft 4 ins / &lt; 163cms</td>
</tr>
<tr>
<td><strong>Build</strong></td>
<td>plumpish / medium / solid / stocky</td>
</tr>
<tr>
<td><strong>Hair</strong></td>
<td>blonde / fair / brown (light)</td>
</tr>
<tr>
<td></td>
<td>- shoulder length / bobbed</td>
</tr>
<tr>
<td></td>
<td>- straight</td>
</tr>
<tr>
<td><strong>Colouring</strong></td>
<td>fair / white / caucasian</td>
</tr>
<tr>
<td><strong>Clothes</strong></td>
<td>cream / white / light trousers / pants / jeans</td>
</tr>
<tr>
<td></td>
<td>navy / black jumper / overshirt / cardigan</td>
</tr>
<tr>
<td></td>
<td>white tshirt under</td>
</tr>
<tr>
<td></td>
<td>black shoes</td>
</tr>
<tr>
<td></td>
<td>- court / flat</td>
</tr>
<tr>
<td></td>
<td>large white / cream / beige bag</td>
</tr>
<tr>
<td>Scenario</td>
<td>Score</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Four people talking</td>
<td></td>
</tr>
<tr>
<td>- friends 2 females and 1 male</td>
<td>3</td>
</tr>
<tr>
<td>Victim leaves group</td>
<td></td>
</tr>
<tr>
<td>Offender approaches victim</td>
<td>2</td>
</tr>
<tr>
<td>Talks to victim</td>
<td>1</td>
</tr>
<tr>
<td>Asks question / time</td>
<td>3</td>
</tr>
<tr>
<td>Snatches at bag</td>
<td>2</td>
</tr>
<tr>
<td>Struggle</td>
<td>2</td>
</tr>
<tr>
<td>Raises fist to hit her</td>
<td>4</td>
</tr>
<tr>
<td>- right handed</td>
<td></td>
</tr>
<tr>
<td>Knocks her to ground</td>
<td>5</td>
</tr>
<tr>
<td>Runs off</td>
<td>5</td>
</tr>
<tr>
<td>Looks in bag</td>
<td>3</td>
</tr>
<tr>
<td>3 friends help victim</td>
<td>6</td>
</tr>
<tr>
<td>- male friend chases offender</td>
<td></td>
</tr>
<tr>
<td>Gets into white car</td>
<td>6</td>
</tr>
<tr>
<td>- small sedan / mazda capella / corolla / nissan</td>
<td>1</td>
</tr>
<tr>
<td>- 4 door</td>
<td>2</td>
</tr>
<tr>
<td>* - pinstripes red / black / blue (two colours)</td>
<td>6</td>
</tr>
<tr>
<td>- wave detail on car</td>
<td>6</td>
</tr>
<tr>
<td>* - Alain Delon written on car</td>
<td>6</td>
</tr>
<tr>
<td>* - Reg 8IA 305</td>
<td>6</td>
</tr>
<tr>
<td>Parked in disabled bay</td>
<td>5</td>
</tr>
</tbody>
</table>

**Note.** The column “judges” refers to the number of judges who identified this item as being important to eyewitness recall. An asterisk (*) means that these items were scored half a point if full details were not given (e.g. only half the number plate would earn half a point).
Dear Participant,

This study is being conducted as part of my Honours degree at Edith Cowan University. The purpose of the study is to investigate eyewitness memory. You will be asked to recall a slide sequence you have been shown; you may be asked to complete the task under test conditions.

Your participation is voluntary, and if you agree to participate you are able to withdraw at any time during the procedure. Participation or non-participation will have no bearing on your employment with the bank. The information obtained is totally anonymous, and you will not be required to give any information which will identify you.

The information obtained from this research will be of use in understanding memory processes. If you wish to find out the results of the study, please feel free to write to me (care of my supervisor) requesting a summary.

Should you have any queries regarding this project please feel free to contact me, or my University supervisor at the address below.

Yours sincerely,

Mary-Anne Martin
Ph 9451 3325

Supervisor
Professor Don Thomson
School of Psychology
Edith Cowan University
Joondalup Campus
Ph 9400 5626

I (the participant) have read the information above and any questions I have asked have been answered to my satisfaction. I agree to participate in this activity, realising I may withdraw at any time.

I agree that the research data gathered for this study may be published provided I am not identifiable.

Name.............................................................................. Date.............................

Signature........................................................................
19th June, 1997

Customer Service Manager
XXXX Bank

Dear XXX

I am currently completing my Honours in Psychology degree at Edith Cowan University. As part of my degree, I am required to conduct a research project. My area of interest is eyewitness memory, and I seek your permission to use staff from your service centre as participants in my study.

This research can be conducted in conjunction with a staff training session on service centre and hold up procedures, which I am happy to run. In this way we can all receive some benefit from the research. The session will take about 30 minutes, and consists of my showing a series of slides of a re-enactment of a handbag snatch, which the staff will be asked to recall details about. If you have any staff who you feel may be adversely affected by this procedure, can you please advise me beforehand so I can leave them out of the study. Staff will be required to give individual consent and will be able to decline or withdraw if they wish to.

If you agree to my proposal, can you please sign the bottom of this page and return to me.

Yours sincerely,

Mary-Anne Martin

I have had the proposed research explained to me and agree to this procedure being carried out at XXXX Branch on a date yet to be determined.

Customer Service Manager
XXXX Bank
### Appendix E

#### Table E1

**Split Plot ANOVA for Recall Scores (Experiment 1)**

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Between subjects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immediate stress</td>
<td>4.40</td>
<td>1</td>
<td>4.40</td>
<td>0.09</td>
<td>0.768</td>
</tr>
<tr>
<td>Delayed stress</td>
<td>16.28</td>
<td>1</td>
<td>16.28</td>
<td>0.32</td>
<td>0.572</td>
</tr>
<tr>
<td>Immediate x delayed</td>
<td>88.40</td>
<td>1</td>
<td>88.40</td>
<td>1.76</td>
<td>0.190</td>
</tr>
<tr>
<td>Subjects within groups</td>
<td>2915.77</td>
<td>58</td>
<td>50.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Within subjects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time of test (T)</td>
<td>73.80</td>
<td>1</td>
<td>73.80</td>
<td>28.51</td>
<td>0.000</td>
</tr>
<tr>
<td>T x immediate stress (I)</td>
<td>3.89</td>
<td>1</td>
<td>3.89</td>
<td>1.50</td>
<td>0.226</td>
</tr>
<tr>
<td>T x delayed stress (D)</td>
<td>22.70</td>
<td>1</td>
<td>22.70</td>
<td>8.77</td>
<td>0.004</td>
</tr>
<tr>
<td>T x I x D</td>
<td>32.27</td>
<td>1</td>
<td>32.27</td>
<td>12.47</td>
<td>0.001</td>
</tr>
<tr>
<td>T x subjects within groups</td>
<td>150.12</td>
<td>58</td>
<td>2.59</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note.** Immediate and delayed stress refer to the manipulation of stress at recall and not participants' stress ratings.
Table E2

Split Plot ANOVA for Recall Scores (Experiment 2)

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Between subjects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immediate stress</td>
<td>0.67</td>
<td>1</td>
<td>0.67</td>
<td>0.02</td>
<td>0.889</td>
</tr>
<tr>
<td>Delayed stress</td>
<td>10.40</td>
<td>1</td>
<td>10.40</td>
<td>0.31</td>
<td>0.583</td>
</tr>
<tr>
<td>Immediate x delayed</td>
<td>135.64</td>
<td>1</td>
<td>135.64</td>
<td>3.98</td>
<td>0.051</td>
</tr>
<tr>
<td>Subjects within groups</td>
<td>2081.70</td>
<td>61</td>
<td>34.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Within subjects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time of test (T)</td>
<td>32.75</td>
<td>1</td>
<td>32.75</td>
<td>11.07</td>
<td>0.001</td>
</tr>
<tr>
<td>T x immediate stress (I)</td>
<td>52.36</td>
<td>1</td>
<td>52.36</td>
<td>17.70</td>
<td>0.000</td>
</tr>
<tr>
<td>T x delayed stress (D)</td>
<td>0.26</td>
<td>1</td>
<td>0.26</td>
<td>0.09</td>
<td>0.768</td>
</tr>
<tr>
<td>T x I x D</td>
<td>0.09</td>
<td>1</td>
<td>0.09</td>
<td>0.03</td>
<td>0.866</td>
</tr>
<tr>
<td>T x subjects within groups</td>
<td>180.43</td>
<td>61</td>
<td>2.96</td>
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</tr>
</tbody>
</table>

Note. Immediate and delayed stress refer to the manipulation of stress at recall and not participants' stress ratings.
Table E3

Mean Error Scores for Immediate and Delayed Recall (Experiment 2)

<table>
<thead>
<tr>
<th>Condition</th>
<th>NSNS (n=16)</th>
<th>NSS (n=16)</th>
<th>SNS (n=17)</th>
<th>SS (n=16)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Offender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immediate</td>
<td>1.06</td>
<td>1.29</td>
<td>0.88</td>
<td>0.81</td>
</tr>
<tr>
<td>Delayed</td>
<td>0.88</td>
<td>1.02</td>
<td>0.75</td>
<td>0.77</td>
</tr>
<tr>
<td>Victim</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immediate</td>
<td>0.69</td>
<td>0.87</td>
<td>1.00</td>
<td>0.82</td>
</tr>
<tr>
<td>Delayed</td>
<td>1.19</td>
<td>1.17</td>
<td>1.19</td>
<td>0.98</td>
</tr>
<tr>
<td>Scenario</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immediate</td>
<td>0.25</td>
<td>0.45</td>
<td>0.19</td>
<td>0.40</td>
</tr>
<tr>
<td>Delayed</td>
<td>0.25</td>
<td>0.58</td>
<td>0.19</td>
<td>0.54</td>
</tr>
<tr>
<td>Total Errors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immediate</td>
<td>2.00</td>
<td>1.71</td>
<td>2.06</td>
<td>1.53</td>
</tr>
<tr>
<td>Delayed</td>
<td>2.19</td>
<td>1.42</td>
<td>2.13</td>
<td>1.41</td>
</tr>
</tbody>
</table>

Note. Columns may not total due to rounding.
### Appendix F

#### OFFENDER 1

<table>
<thead>
<tr>
<th>Category</th>
<th>Observed frequency (O)</th>
<th>Expected proportion (P)</th>
<th>Expected frequency (E)</th>
<th>O-E</th>
<th>(O-E)²</th>
<th>(O-E)² E</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSNS</td>
<td>17</td>
<td>0.25</td>
<td>14</td>
<td>3</td>
<td>9</td>
<td>0.6429</td>
</tr>
<tr>
<td>NSS</td>
<td>14</td>
<td>0.25</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SNS</td>
<td>17</td>
<td>0.25</td>
<td>14</td>
<td>3</td>
<td>9</td>
<td>0.6429</td>
</tr>
<tr>
<td>SS</td>
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<td>-6</td>
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<tr>
<td>Σ</td>
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<td>1</td>
<td>56</td>
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<td>3.8572</td>
</tr>
</tbody>
</table>

\[ df = (4-1) = 3 \quad \alpha = .05 \quad \text{critical value} \quad \chi^2 = 7.81473 \]

\[ \text{observed } \chi^2 = 3.8572 < \text{critical } \chi^2 = 7.81473 \]

#### OFFENDER 2

<table>
<thead>
<tr>
<th>Category</th>
<th>Observed frequency (O)</th>
<th>Expected proportion (P)</th>
<th>Expected frequency (E)</th>
<th>O-E</th>
<th>(O-E)²</th>
<th>(O-E)² E</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSNS</td>
<td>14</td>
<td>0.25</td>
<td>12.5</td>
<td>1.5</td>
<td>2.25</td>
<td>0.18</td>
</tr>
<tr>
<td>NSS</td>
<td>12</td>
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<td>12.5</td>
<td>-0.5</td>
<td>0.25</td>
<td>0.02</td>
</tr>
<tr>
<td>SNS</td>
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<td>0.25</td>
<td>12.5</td>
<td>6.5</td>
<td>42.25</td>
<td>3.38</td>
</tr>
<tr>
<td>SS</td>
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<td>0.25</td>
<td>12.5</td>
<td>-7.5</td>
<td>56.25</td>
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</tr>
<tr>
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<td>1</td>
<td>50</td>
<td>-7.5</td>
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\[ df = (4-1) = 3 \quad \alpha = .05 \quad \text{critical value} \quad \chi^2 = 7.81473 \]

\[ \text{observed } \chi^2 = 8.08 > \text{critical } \chi^2 = 7.81473 \]
### VICTIM 1

<table>
<thead>
<tr>
<th>Category</th>
<th>Observed frequency (O)</th>
<th>Expected proportion (P)</th>
<th>Expected frequency (E)</th>
<th>O-E</th>
<th>(O-E)²</th>
<th>(O-E)² E</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSNS</td>
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<td>0.25</td>
<td>16.25</td>
<td>-5.25</td>
<td>27.5625</td>
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</tr>
<tr>
<td>NSS</td>
<td>16</td>
<td>0.25</td>
<td>16.25</td>
<td>-0.25</td>
<td>0.0625</td>
<td>0.0038</td>
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<tr>
<td>SNS</td>
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<td>16.25</td>
<td>6.75</td>
<td>45.5625</td>
<td>2.8038</td>
</tr>
<tr>
<td>SS</td>
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<td>16.25</td>
<td>-1.25</td>
<td>1.5625</td>
<td>0.0096</td>
</tr>
<tr>
<td><strong>Σ</strong></td>
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<td><strong>65</strong></td>
<td>0</td>
<td></td>
<td><strong>4.5092</strong></td>
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</tbody>
</table>

\[
df = (4-1) = 3 \quad \alpha = .05 \quad \text{critical value} \quad \chi^2 = 7.81473
\]

observed \( \chi^2 = 4.5092 \) < critical \( \chi^2 = 7.81473 \)

### VICTIM 2

<table>
<thead>
<tr>
<th>Category</th>
<th>Observed frequency (O)</th>
<th>Expected proportion (P)</th>
<th>Expected frequency (E)</th>
<th>O-E</th>
<th>(O-E)²</th>
<th>(O-E)² E</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSNS</td>
<td>19</td>
<td>0.25</td>
<td>18.75</td>
<td>0.25</td>
<td>0.0625</td>
<td>0.0033</td>
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<tr>
<td>NSS</td>
<td>19</td>
<td>0.25</td>
<td>18.75</td>
<td>0.25</td>
<td>0.0625</td>
<td>0.0033</td>
</tr>
<tr>
<td>SNS</td>
<td>21</td>
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<td>18.75</td>
<td>2.25</td>
<td>5.0625</td>
<td>0.27</td>
</tr>
<tr>
<td>SS</td>
<td>16</td>
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<td>18.75</td>
<td>-2.75</td>
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<tr>
<td><strong>Σ</strong></td>
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<td><strong>75</strong></td>
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</table>

\[
df = (4-1) = 3 \quad \alpha = .05 \quad \text{critical value} \quad \chi^2 = 7.81473
\]

observed \( \chi^2 = 0.6799 \) < critical \( \chi^2 = 7.81473 \)
### Scenario 1

<table>
<thead>
<tr>
<th>Category</th>
<th>Observed frequency (O)</th>
<th>Expected proportion (P)</th>
<th>Expected frequency (E)</th>
<th>O-E</th>
<th>(O-E)^2</th>
<th>(O-E)^2 E</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSNS</td>
<td>4</td>
<td>0.25</td>
<td>3.125</td>
<td>0.875</td>
<td>0.7656</td>
<td>0.245</td>
</tr>
<tr>
<td>NSS</td>
<td>3</td>
<td>0.25</td>
<td>3.125</td>
<td>-0.125</td>
<td>0.0156</td>
<td>0.005</td>
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<tr>
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<td>3.125</td>
<td>-0.625</td>
<td>0.3906</td>
<td>0.125</td>
</tr>
<tr>
<td>SS</td>
<td>3</td>
<td>0.25</td>
<td>3.125</td>
<td>-0.125</td>
<td>0.0156</td>
<td>0.005</td>
</tr>
<tr>
<td>Σ</td>
<td>12.5</td>
<td></td>
<td>12.5</td>
<td>0</td>
<td></td>
<td>0.38</td>
</tr>
</tbody>
</table>

\[ df = (4-1) = 3 \]
\[ \alpha = 0.05 \]
\[ \chi^2 \text{ critical value} = 7.81473 \]
\[ \chi^2 = 0.38 < \text{critical} \]

### Scenario 2

<table>
<thead>
<tr>
<th>Category</th>
<th>Observed frequency (O)</th>
<th>Expected proportion (P)</th>
<th>Expected frequency (E)</th>
<th>O-E</th>
<th>(O-E)^2</th>
<th>(O-E)^2 E</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSNS</td>
<td>4</td>
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<td>2.875</td>
<td>1.125</td>
<td>1.266</td>
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<tr>
<td>NSS</td>
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<td>2.875</td>
<td>0.125</td>
<td>0.0156</td>
<td>0.0054</td>
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<tr>
<td>SNS</td>
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<td>2.875</td>
<td>-0.375</td>
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<td>0.0489</td>
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<tr>
<td>SS</td>
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<td>0.25</td>
<td>2.875</td>
<td>-0.875</td>
<td>0.7656</td>
<td>0.2663</td>
</tr>
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<td>0</td>
<td></td>
<td>0.7609</td>
</tr>
</tbody>
</table>

\[ df = (4-1) = 3 \]
\[ \alpha = 0.05 \]
\[ \chi^2 \text{ critical value} = 7.81473 \]
\[ \chi^2 = 0.7609 < \text{critical} \]