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The Effects of Arousal on Memorial Accuracy: A Comparison of Arousal as Part of Content Material and Arousal as Part of Contextual Environment

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ABSTRACT

The Effects of Arousal on Memorial Accuracy: A Comparison of Arousal as Part of Content Material and Arousal as Part of Contextual Environment

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Concordia University, 2000

In an attempt to examine the effect of arousal on memory, the present study investigated whether the source of arousal had any influence on the incidental memory of a short slide show. Specifically, memory of arousing content was compared to memory of material while in an arousing emotional state. A total of 104 volunteers were randomly assigned to one of four experimental groups. All groups watched the same 11 slides but heard either an arousing or neutral version of the story accompanying the slide show. Furthermore, half of the subjects were exposed to background sounds that were either arousing in nature or neutral while watching the neutral version of the slide show. Subjects' memory was tested either immediately following the slide show or after a one-week delay. The memory test consisted of both a free recall task and a multiple-choice recognition test. The free recall task was closely examined for gist, central and background detail, erroneous substitutions, fictional additions and attributions. Being exposed to arousing background sounds consistently impaired memory more significantly than exposure to neutral background sounds. Viewing the arousing story did improve memory on the free recall task for gist and background details, especially when the retention interval was delayed. However, this group also made consistently more errors in their recall as well, especially after a delay. A capacity for imagery and imaginative thinking (as measured by the Individual Differences Questionnaire) was found to reliably predict the number of memory intrusions (i.e., errors and attributions) subjects made in their recall. Implications for eyewitness testimony and memory for traumatic events are discussed.

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INTRODUCTION

Most of us have had the experience of believing strongly in the accuracy of a memory only to realize later that we were wrong. We are convinced we parked the car in point A only to realize it was really three blocks away. Despite these rampant memory failures, few of us would dispute that our memories serve us well (Mather, Henkel & Johnson, 1997). Through them, we define who we are, what our childhood was like and how we present ourselves to those who surround us. Indeed, amnesic patients are lost and dysfunctional without their memories. Only rarely in everybody's life do we confront the veracity of our memories. It appears then, that memory unreliability becomes an issue only when detailed information or corroboration is asked of us (Heuer & Reisberg, 1992). Fortunately, it is rarely relevant to our lives. Detailed information, however, becomes critical in the eyewitness world where eyewitness testimonies are of great consequentiality. If detailed memory is unreliable, why do we rely so strongly on such testimonies for criminal investigations? The argument has been convincingly made by adherents of the "flashbulb memory" paradigm that the emotional nature of these situations (i.e., crime scenes) render the details of such memories immune to the usual decay of forgetting (Yuille & Tollestrup, 1992).

Intuitively, this argument makes sense. Most of us have a few very vivid memories from our past that we can recall without much hesitation and with great detail: memories of a birthday party, a trip far from home, a special toy, etc. These vivid memories of our past are often very emotional in nature. But while we have a few of these recollections that strikingly stand out from our past, the rest of our memories for most us have faded away. Few of us can remember such fleeting events as what we had for dinner last Tuesday, or what we did three Sundays ago. What is it about these emotional memories that makes them

more salient to us? Are these emotional memories somehow different from other memories? Does the emotional component somehow affect the memorial process in rendering it either more accurate or less so, perhaps? These questions are particularly critical to the issue of eyewitness testimony since much of what is asked to recall in these situations is detailed information that is invariably emotional in nature. The purpose of the present thesis is to assess the role emotions play in memorial accuracy.

Unfortunately, the area of affect and memory is far from providing researchers and law advocates with clear answers to these questions. Methodological variability, little consensus among researchers and the absence of an integrated theory characterize the area. The fragmented nature of the field stems most probably from the multitude of areas that combine their research efforts to the understanding of the relations between affect and memory. Physiological psychologists, for example, focus on the biological aspects of affect, social psychologists direct their research efforts to the affective components in social judgments and social behavior, cognitive psychologists study memory processes, and even marketing scientists have their own interests in examining the effects of affect on memory with regards to memory for product attributes. Researchers from each of these areas have approached the problem with their own idiosyncratic methodologies and have found somewhat differing results that are sometimes difficult to reconcile. The multi-dimensionality of the area of affect and memory renders reviewing the literature a complex and challenging task.

The present dissertation will critically review and integrate findings from the different literatures in order to gain a better understanding of the role played by affect or more specifically intensity of affect on memorial accuracy in general. To this end, the following sections will review the evidence pertaining to

memorial malleability and reliability with an examination of the special context of hypnosis and the creation of pseudomemories in that context revealing the role for individual differences. There is indeed a great deal of debate among theorists as to the extent to which memory is malleable. Next, a review of how mood and affect adds to the equation of memory malleability will include a discussion of the major theoretical frameworks on transient mood effects on memory, the ensuing hypotheses and existing evidence for them. As well, a detailed look at the effects of arousal on memorial accuracy will provide additional clarification of the relation between affect and memory since intensity of affect appears to be a key modulating factor (Fiedler & Stroehm, 1986). Finally, a recapitulation of the integrated conclusions on memory malleability and the role played by arousal effects on the one hand and individual differences on the other will lead us to the present study. The main purpose of the study is to compare memory of arousing stimuli with the memory of neutral stimuli in an arousing environmental context. Such a comparison will allow us to tease apart the key components at play in arousal's effects on memory, which most closely parallels the eyewitness context.

The following sections will therefore evaluate the evidence of memory malleability by focusing on the conditions under which memory sometimes becomes unreliable. A contrasting view is also presented with conditions under which memory is usually accurate and reliable. Next, a review of the theories that guide people's decision-making processes about what is real and what is not and an overview of the characteristics that differentiate real events from imagined events will help clarify the issue of memory malleability even further. Finally, a look at how individual differences in memory ability, especially in the permissive context of hypnosis will help explain the absence of clear categorical conclusions about memory malleability and accuracy.

Memorial accuracy

There is great debate among theorists as to the accuracy of our memories (Kassin, Ellsworth & Smith, 1989; Yarmey & Jones, 1983). After all, our memories serve us well (Mather et al., 1997) and without them, we are without personal identity. More and more evidence is gathering, however, in painting memory as a reconstructive process (e.g., Lindsay, 1990; Loftus, Donders, Hoffman & Schooler, 1989; Loftus & Ketcham, 1983). The reconstructive nature of memory is even evident in such simple tasks as memory for letters and digits (Mewaldt & Hinrichs, 1977). Even proponents of the view of memory as generally accurate are finding themselves specifying more and more conditions for this accuracy in memory (Alba & Hasher, 1983; Johnson & Raye, 1981; Mather et al., 1997).

Loftus and her colleagues have become the most recent pioneers in revealing the malleable nature of memory processes (e.g., Loftus et al., 1989; Loftus & Hoffman, 1989; Weingardt, Loftus & Lindsay, 1995). One of their most popular finding is the "misinformation effect", which mainly entails the contamination of subjects' recall of material by the introduction of post-event false information. The paradigm essentially involves the presentation of visual material to subjects, followed by a written/verbal narrative with some false information about the visual stimuli and a recall of the original information seen by subjects. In addition to common human error, the misinformation effect has actually shown to mislead an additional 30% of subjects into claiming to have seen a merely suggested event. This statistic represents true memory contamination and was derived at by subtracting the number of control subjects claiming the suggestion in final tests (i.e., random human error) from those claiming it in experimental groups (i.e., truly misled subjects). This statistic appears to be quite stable since attempts to maximize the effect have failed to

increase the number of subjects that are misled (Loftus et al., 1989).

Loftus and her colleagues have shown that misinformation can not only supplement the original memory but can actually transform the original event (e.g., Lane & Zaragosa, 1995); for example, a stop sign can be replaced by a suggested yield sign (Loftus, 1979b). The fact that these suggested memories are subsequently adhered to with great confidence by subjects (Loftus et al., 1989) points to the potentially dangerous consequences of such memory distortions. Indeed, the positive association between memorial accuracy and subjects' confidence ratings that is normally present when subjects are not misled, disappears when subjects are successfully misled (Loftus et al., 1989). The suggested information does not even need to be directly mentioned. It can be implied through simple questioning. Subjects are more likely to say they saw broken glass if the question made use of strong verbs such as "when the cars *smashed* into one another" than a control question such as "when the cars *hit* one another" (Loftus, 1979b).

Loftus (1979a) has even succeeded in misleading subjects about blatantly contradictory information, that is, stimuli that were particularly noticeable to subjects, so long as certain conditions were met. For example, the blatantly false information must be plausible within the context such as seeing a telephone booth within an urban scene or a water pump within a farm scene (49% of subjects misled with plausible information versus 24% of controls) rather than vice versa (21% of subjects misled with implausible information versus 1% of controls). Interestingly, those who were successfully misled with blatantly contradictory evidence were more confident about implausible items than plausible ones. It seems the more outrageous one's claim is, the more confident one will be about its veracity. Furthermore, the source of the false information must be credible (Loftus, 1979a). Loftus had actually told her subjects that a

university professor had written the narratives. Generally, subjects who are presented with blatantly false information will be much more resistant to subsequent contextual manipulations unless there is a delay between the event and the blatant information (Loftus, 1979a).

Despite the seeming robustness of the suggestibility effect, it does appear to depend on several contextual manipulations. The main focus of all of the studies mentioned earlier, for example, is on misleading subjects about non-salient information. Within Loftus' paradigm, rarely can subjects be misled on central information. Furthermore, the false suggestion is especially influential to subjects' subsequent recall if it is embedded within a parenthetical clause rather than the main focus of the question (Schooler, Gerhard & Loftus, 1986). The phenomenon is only apparent when subjects' attention is diverted since the use of a distractor task is mandatory for the observation of the suggestibility effect (Loftus, 1979b). A delay between the original material and the presentation of the false suggestion also leads to greater memory contamination (Loftus & Hoffman, 1989; Loftus & Ketcham, 1983), most probably because the memory traces of the event information have had time to decay. Greater suggestibility effects have also been found to occur with recall rather than recognition tasks although they still occur with the latter as well (Loftus, 1979b).

There are also a number of conditions that can moderate the phenomenon. When subjects commit themselves to an answer, for example, they are subsequently more resistant to being misled about it (Loftus & Ketcham, 1983). Also, recalling information even once before the presentation of misinformation appears to work as a rehearsal technique, organizing subjects' memory system in preventing assimilation of inconsistent material (Loftus, 1979a). Interestingly, face recognition has been argued to be special and thus more immune to the misinformation effect. Subjects have been found to be

particularly good at face recognition, especially after a delay (Loftus & Ketcham, 1983). Unfortunately, simply seeing a face in a mugshot increases the chances that it will be chosen later in a lineup (Yarmey & Jones, 1983). Furthermore, when reading erroneous descriptors of a face, a third of subjects incorporated them in their recall and 70% of subjects included the error in their recognition (Loftus & Ketcham, 1983). Warnings do somewhat help subjects' memorial accuracy but only if warnings are given prior to presentation of the misinformation (Loftus & Ketcham, 1983). This seems to suggest that the misinformation effect is due to lack of careful scrutiny of information or subject vulnerability to information bias.

Further evidence linking the suggestibility effect to reduced critical processing of material comes from the fact that sentence complexity contributes to greater vulnerability to false information. The more complex the question in which the misinformation is embedded, the more likely subjects are to incorporate the misinformation into their subsequent recall. Via simple sentences, 26% of subjects were misled, via complex sentences, this figure rose to 39% (Loftus & Ketcham, 1983). Also, respecting the temporal presentation of the original stimuli in the questions posed to participants has been found to reduce the misinformation effect (Alba & Hasher, 1983). Additional support for this claim comes from the fact that subjects' interest in the material also appears to shield them from the misinformation effect (Johnson, Hashtroudi & Lindsay, 1993). The assumption here is that interest in the material leads to more careful survey of the material and less susceptibility to false claims about it.

In line with this series of inquiry, a great deal of research has focused on uncovering the mechanisms involved in the misinformation effect. One set of evidence suggests that subjects integrate both original stimuli and misinformation into a single unitary experience. This assumption derives from

evidence that presentation of a blue car and subsequent suggestion that it was green, resulted in bluish-green responses when subjects were given color strips as choices (Loftus, 1979a). Furthermore, the integration of the misinformation into the original memory seems to happen at the time of presentation of the misinformation, since reaction times actually reveal that subjects are no slower at choosing the suggested item as response than the correct answer. This clearly indicates the absence of any decision-making conflict at the time of retrieval (Loftus, 1979a; Loftus et al., 1989).

It has been suggested that the mechanism involved in the suggestibility effect may follow from source monitoring breakdown. The argument here is that misled subjects may be responding in terms of familiarity of material rather than truly being misled. At the time of recall, if subjects retrieve the suggested item, they may be less likely to keep searching their memory for event detail. There is some evidence that when a source monitoring test is included in a recognition test, the suggestion effect can be reduced (Lindsay, 1990).

Some theorists have adopted Jacoby's logic of opposition paradigm to clarify whether the misinformation effect is truly a source monitoring issue. The paradigm makes it clear for participants that they are to report information seen either exclusively from the slides (Lindsay, 1990) or exclusively from the narrative (Weingardt et al., 1995) but not both. In this way, the argument of familiarity of material being responsible for the misinformation effect can be eliminated, since subjects are asked to discriminate between information presented in the narrative and in the slides. The results invariably show that although the misinformation effect is reduced, in addition to common error, another 12-15% of subjects are misled into not reporting suggested items when they were instructed to exclude only event details, clearly indicating a source monitoring confusion for these subjects. Interestingly, with a delay between

event presentation and misinformation presentation, source monitoring improves for subjects (Lindsay, 1990) contradicting Loftus' claim that a delay between suggestion and event presentation actually leads to more suggestibility. The contradictory conclusions are probably due to different methodological manipulations between the Loftus paradigm and the logic of opposition paradigm. This demonstrates the extent to which memory phenomena are contrived by varying contextual manipulations. Loftus and Hoffman (1989) have even proposed a Watsonian future for memory where they invite us to give them a dozen healthy memories and their own specified world and we have their promise that they will at random train the memories to become anything we want them to.

Fortunately, our world is not contextually manipulated to consistently and artificially mislead us and some theorists have even argued that the misinformation effect is simply an artifact of the Loftus' testing procedures (Alba & Hasher, 1983). The following sections will review the theories guiding decision-making processes about source monitoring. There is a great deal of research that shows that our memories are reliable even with regards to detailed information. Advocates of a reconstructive view of memory often refer to schema theories of memory to support their claims. Schema theory of memory processes proposes four central encoding processes that are applied to incoming stimuli (Alba & Hasher, 1983). Memory is postulated to be highly selective in that only a subset of what is perceived is stored in memory. Memory is also proposed to be highly abstractive in that verbatim information is rarely stored. Memory is also interpretive in that prior experiences and biases guide comprehension of stored material and help fill in gaps. Finally, memory is integrative with prior knowledge. That is to say that in retrieving the stored information, reconstructive processes might get activated in reproducing the episode with whatever details are

available in memory and might fill in gaps with what is inferred or imagined taking place.

It is proposed that memory distortions can occur at various points along these memory processes. Alba and Hasher (1983) specifically reviewed existing evidence of these theorized processes and found most of the literature to be directly contradictory to these claims. They, for example, found that memory for verbatim material is surprisingly good even after an hour. The memory system was found to be richer with regards to details than schema theory would suggest. With regards to interpretive processes, the evidence suggests that subjects often fail to make even the simplest inferences about the material. Evidence indicating subjects actually store separate unintegrated units of the original material (e.g., Powers & Kumar, 1974) also fails to support the claim that integrative memory processes are uniformly applied to all incoming stimuli. Alba and Hasher (1983) conclude on the basis of these findings, that memory distortions are not that common under normal conditions.

After all, the phenomenon of misinformation is essentially modality confusion. Subjects are simply mistaking what they read about with what they saw. As a matter of fact, at the basis of all errors of memory lies the failure to uncover the original source of information. Even in the context of hypnosis, when a simple suggestion can lead to the creation of false memories in about half of highly susceptible subjects (e.g., Labelle, Laurence, Nadon & Perry, 1990), the erroneous claims are due to a failure to discriminate between internally imagined events and externally perceived events. Effective source monitoring allows us to tell the difference between fantasies/delusions and reality. The source-monitoring theory proposes guidelines into people's decision-making processes for distinguishing the origins of stored memories. These guidelines will help explain how the evidence can, on the one hand, reveal memory to be reliable

and, on the other, still show the phenomenon of memory contamination so reliably.

Cues such as sensory/perceptual information, contextual (i.e., spatial, temporal) characteristics, semantic detail, affective component and cognitive operations can help guide source monitoring. The type, amount and uniqueness of characteristics as well as the stringency of the criterion used for decision-making will determine the ease with which one will assess the source of a memory (Johnson et al., 1993). With increasing semantic and sensory similarity between memories from different sources and with the passage of time, the more likely it is for a person to confuse the memories. On the other hand, with increasing information about the memory (i.e., such as cued recall), or cognitive operations, the less likely it is for confusion about source monitoring to exist (Johnson & Raye, 1981). These claims are certainly supported by the literature on the misinformation effect reviewed earlier since the paradigm focuses on misleading subjects about items highly similar in semantic and sensory characteristics with increasing time lapses between them, etc. Although there is not much evidence to support it, there are those that claim that subjects' "remember" versus "know" judgements can help guide source monitoring (Lane & Zaragoza, 1995; Mather et al., 1997).

There are also interesting asymmetries found in source monitoring confusion that shed some light on the two phenomena of false memory creation: the misinformation effect as well as the hypnotic creation of pseudomemories. Reading about something can often lead to imagined perceptions of it but rarely does seeing something lead one to claim having read about it. Reading gives rise to imagery but images do not give rise to imagined reading (Johnson et al., 1993). This could explain the robustness of the misinformation effect given the typical Loftus paradigm whereby subjects see a slide show and later read the

suggested material. There is also evidence that people appear to be more likely to confuse one's own imagined doing with actual doing rather than one's own doing with someone else's doing (Johnson et al., 1993). This has been supported by the pseudomemory literature in that suggestions are more typically geared toward confusing subjects' imagined doing with actual doing rather than the hypnotist's actions (e.g., Labelle et al., 1990; Laurence, Nadon, Nogrady & Perry, 1986).

The von Restorff phenomenon is another demonstration of the source-monitoring theory in that the unique and distinctive characteristics of an event can render it more salient and memorable (Wallace, 1965). Bizarre or high imagery stimuli, for example, are recalled twice as much as common or low imagery material (McDaniel & Einstein, 1986; Shaw, Bekerian & McCubbin, 1995). Of course the distinctiveness of the stimuli depends invariably on the relative contrast of surrounding stimuli, in that unusual items become even more distinct in the context of common ones. The effect only appears, therefore, if the distinct items are presented to subjects along with common ones. The effect does seem to be limited to recall rather than recognition of material but does not seem to depend on the amount of processing time subjects dedicate to the bizarre material (McDaniel & Einstein, 1986). This latter observation strongly suggests that characteristics inherent in the distinct stimuli themselves are responsible for their increased memorability and not the amount of viewing time the stimuli benefit.

The parallel can be drawn here with the eyewitness context. The witnessing of a crime scene strikingly contrasts with common day to day situations and stands out as a more distinct and intact memory that might be better recalled than routine activities. The only field study application of this effect was done by Brigham, Maass, Snyder and Spaulding (1982). They

interviewed convenience store clerks who had had unusual encounters with two confederate clients two hours earlier and asked them to identify them from an 8-photo lineup. Results indicated that despite the distinctiveness or unusualness of the situation, subjects were only 34% accurate in their identifications. Unfortunately, the absence of a control group in this study fails to provide a baseline level of identification accuracy. Nevertheless, it does not appear that unusual encounters in the field setting contribute to increased memorability.

In summary, the previous review of the literature indicates that the effectiveness of source monitoring appears to depend on ideal situational conditions and that it is relatively easy to confuse the original sources of stored memories. A great deal of research, however, supports the source-monitoring theory with regards to reality monitoring. Indeed, there appears to be very specific discriminating characteristics between externally generated events and internally generated events. External perceptual events have been found to be richer with regards to sensory/perceptual properties as well as contextual (i.e., spatial, temporal) characteristics. Internal imagined events are somewhat longer in descriptions and characterized by more cognitive operations such as "I think..." (Johnson et al., 1993; Johnson & Raye, 1981; Schooler, Clark & Loftus, 1988; Schooler et al., 1986). Others have found false memories to be less confidently held and less emotionally reactive by subjects than true memories (Mather et al., 1997; Schooler et al., 1986).

Although this latter finding appears to contradict earlier evidence that false memories are frequently held with great confidence, the interpretation of the findings really depend on the relative comparison group chosen. The evidence shows that true memories are more confidently believed in than false memories but false memories are still strongly adhered to by subjects since their confidence level fails to differentiate between real and false memories (Kenney,

1989; Loftus et al., 1989). Overall, the above-mentioned differentiating characteristics between real and imagined events appear to be quite stable and replicable observations. Indeed, whether misled subjects' descriptions of suggested items are compared with those of truly perceived items (Schooler et al., 1986), or whether subjects' accurate reproductions of material are compared with inaccurate ones (Schooler et al., 1988), or whether genuinely forgetful subjects' protocols are compared with those of simulators (Schacter, 1986), the results are surprisingly similar. The extent to which sensory/perceptual and contextual characteristics as well as cognitive operations and length of descriptions are present in the protocols accurately distinguish real from imagined events.

Despite the robustness of these differentiating characteristics between real and imagined events, however, experimentally blind subjects have consistently been found to be poor judges of protocol classification (Schacter, 1986; Schooler et al., 1986; 1988). Even though providing hints and training to judges has somewhat improved performance (Schooler et al., 1986), these characteristics fail to provide clear guidelines for differentiating between real witness accounts of what happened and accounts tinged with inferences and post-event contamination, etc. Before one is tempted to dismiss all witness testimonies, however, it is important to note that the misinformation effect or true memory contamination consistently affects only a third of subjects and pseudomemories affects mostly highly hypnotizable subjects. This observation points to crucial individual differences in memorial ability and malleability. The few studies that have specifically looked at individual differences in everyday memory have found subjects to be good judges of their own memorial ability (e.g., Martin, 1988). Individual differences are particularly evident in the context of hypnosis where the extensive malleable nature of some individuals' memories

is easily revealed.

Hypnosis represents an especially permissive context (Yuille & Kim, 1987) which appears to amplify any pre-existing memory vulnerability to distortions (for elaboration see Laurence & Perry, 1988). In this context, researchers have not just succeeded in misleading subjects about non-salient event details but have actually succeeded in creating false memories about central events in a selective group of individuals (Lynn & Nash, 1994). Three different paradigms have been used to create hypnotic pseudomemories in subjects. One of these is the suggested noise phenomenon of night sleep in hypnosis. Subjects are asked pre-hypnotically to recall an evening where they peacefully slept through the night without interruptions. During hypnosis, they are regressed back to the night in question and a suggestion is given to them that loud noises from outside woke them up (Laurence et al., 1986). Another popular paradigm has subjects watching a bank robbery videotape pre-hypnotically and later in hypnosis suggests to them that the robber was wearing a mask, swearing and entering from the left rather than the right (Sheehan, Statham & Jamieson, 1991b). Others have suggested to subjects that on an earlier testing session, the phone rang when actually pencils had spilled during that session (Lynn, Milano & Weekes, 1991) .

These paradigms succeed in creating relatively persistent pseudomemories in about 13-75% of subjects (McCann & Sheehan, 1988; Sheehan, Statham & Jamieson, 1991b). The wide range of pseudomemory claims is indicative of the numerous contributing variables to the phenomenon. Among these are contextual characteristics such as social influence and the hypnotic situation (Sheehan, Statham & Jamieson, 1991a), rapport, task demands (i.e., direct versus indirect measures, reward) (Murrey, Cross & Whipple, 1992; Sheehan, Green & Truesdale, 1992) as well as the type of

suggestions given (i.e., verifiability of the suggestions, etc.) (Lynn & Nash, 1994). Most germane to the present discussion, however, are the various client characteristics that have been found to be crucial contributing factors to pseudomemory claims. First and foremost, hypnotizability of individuals is a key factor in that almost half of highly susceptible subjects claim pseudomemories (as compared to 0% of low hypnotizables) (Laurence & Perry, 1983). Although this statistic is comparable to those simulating pseudomemories, in contrast to simulators, highly hypnotizable subjects tend to elaborate upon suggestions and build an entire narrative around them beyond the hypnotist's intent (Lynn, Rhue, Myers & Weekes, 1994; Weekes, Lynn, Green & Brentar, 1992).

High hypnotizable individuals also appear to paradoxically have excellent verbatim memory of the hypnotic sessions (Lynn, Weekes & Milano, 1991; 1992). High hypnotizable subjects' vulnerability to memory creations does not appear to be limited to the hypnotic context since it has also been observed in dream analysis and free association sessions (Laurence et al., 1986). These observations strongly suggest that individuals claiming pseudomemories tend to have a different cognitive style that sets them apart from those not claiming pseudomemories. In addition to hypnotizability, imaginative involvement in combination with susceptibility to hypnosis are significant predictors of false memory creation (Laurence et al., 1986). Fantasy-prone personality has also been theorized to be a vulnerability factor for false memory creation (Lynn & Nash, 1993). It appears therefore that hypnotic pseudomemories are a result of a complex interaction between contextual manipulations, task demands but most importantly cognitive characteristics such as hypnotizability, imaginative involvement and possibly fantasy-proneness. The relevance of such individual characteristics in memorial ability can explain why so few experts can agree on the overall reliability of memory (Kassin et al., 1989; Yarmey & Jones, 1983).

The question of memory reliability appears to strongly depend on which set of evidence one focuses.

In summary, the good news appears to be that memory is relatively. Unfortunately, the bad news is that memory is easily malleable given fairly simple contextual manipulations. As well, individual differences come into play in sometimes amplifying pre-existing memory vulnerability to distortion. This malleability in the experimental context can translate into seriously dangerous memory distortions in the eyewitness situation. The following sections will review the extensive literature on affect and memory in order to determine the role played by emotions in the context of memorial accuracy. A discussion of the major theoretical positions in the area will be followed by a review of the existing evidence.

Affect and Memory

As mentioned earlier, historically, the area of mood and memory has its roots in physiological psychology such as the James-Lang theory of emotions, information-processing theories and social psychology (Lang, 1979). It is not surprising, therefore that the major theoretical frameworks guiding research in the area have been extended from cognitive psychology. The argument has convincingly been made that emotions are really another form of cognitions since they have the same effects on memory as cognitions do (Laird, 1989). The two major cognitive theoretical perspectives that have been applied to the area of mood and memory are the network theory of affect and the resource allocation theory of affect. The motivational theory of affect is another perspective that has been discussed in the literature lately. The following paragraphs give an overview of each of these.

Bower's network theory of affect has been successfully applied to the

domain of affect (Leichman, Ceci & Ornstein, 1992). It essentially describes the affective system similarly to the cognitive system as an agglomeration of nodes that when activated lead to associated nodes. The major predictions ensuing from this theory are mood-dependent and mood-congruency effects (Singer & Salovey, 1988). Mood-dependency depicts mood as a contextual cue for recall of material. Essentially, memory is said to be facilitated when mood at encoding matches mood at recall. If one learns a given text in a sad mood, then recall of that material will be best when one is once again sad. The second phenomenon predicted by the network theory of affect is mood-congruency effects which entails better recall or learning of material that is congruent with current mood. In its simplest form, it represents best recall of sad material when one is sad and best recall of happy material when one is happy. Mood congruency can be seen for both recall of autobiographical memories (i.e., in that recall of memories congruent with current mood will be facilitated) as well as learning of experimentally-determined material (i.e., in that learning of material affectively-congruent with current mood will be better than learning material incongruent with current mood) (Singer & Salovey, 1988).

The resource allocation theory is the second major perspective proposed to account for the effects of mood states on memory. The model assumes that emotional states disrupt memory because emotions require attentional capacity and by this token reduce resources that can be allocated to any memory task (Ellis & Ashbrook, 1988). These two models are essentially complementary to one another for the most part. With regard to intensity of affect, however, the predictions from the two theories stand in direct opposition. The network theory of affect would predict that mood intensity would be associated with memory effectiveness (Bradley, 1994; Singer & Salovey, 1988). In contrast, the resource allocation model would predict that as mood intensity increases, so does

memory disruptiveness (Ellis & Ashbrook, 1988; 1989). An examination of the evidence on intensive emotions in light of these predictions will be presented later in the paper during the discussion on arousal's effects on memory. This section focuses on the theoretical predictions of the cognitive frameworks.

The cognitive approach reviewed so far postulates predictions about the effects of mood on memory independently of the valence of the mood itself in that both negative and positive affect equally strain attentional resources and are equally subject to mood congruency and mood dependency effects. The more recent motivational approach to affect and memory predicts the effects of mood on memory by specifically focussing on the differential impacts of positive and negative emotions (Asuncion & Lam, 1995; Leichtman et al., 1992). Included in the motivational approach is the Pollyanna principle that as human beings we are all striving to be happy at all times and as such there is a positive response bias in all memory tasks (Thomas & Diener, 1990). Together with the network and resource allocation theories, these approaches would predict that the phenomena of mood congruency and mood dependency would be more evident with positively valenced material because of our natural tendency toward positivity.

In the social realm, motivational theories predict that positive affect leads people to view the world as a safe place and avoid extensive information processing in order to maintain the positive mood (Asuncion & Lam, 1995; Seta, Hayes & Seta, 1994). In contrast, negative affect regulates survival instincts such as avoidance, fight/flight response that leads to a view of the world as problematic where careful scrutiny of all information may be critical (Lang, Dhillon & Dong, 1995). For similar survival purposes, negatively valenced material is theorized to empower individuals for quick automatic processing (Leichtman et al., 1992). The theoretical predictions from the motivational model of emotions'

effects on memory are in some aspects more specific than those from the cognitive perspective and as such the two approaches can be seen as complementary to one another. The following sections will present an overview of the extensive literature on affect and memory in order to critically evaluate the evidence for the theories. Interestingly, the evidence provides relatively good support for most of the theoretical claims indicating the need for an integrated approach in explaining the entire spectrum of mood's effects on memory.

The phenomenon of mood-congruency as predicted by the cognitive theories is well supported by the literature (Blaney, 1986; Leichtman et al., 1992; Suedfeld & Eich, 1995). Whether one studies subjects' learning of affective material or whether subjects are asked to recall autobiograhical memories from their past, mood-congruent memory has been consistently observed. Bower and Mayer (1989), for example, found participants' present mood-facilitated learning of mood-congruent words. MacLeod and Campbell (1992) found that subjects recalled autobiographical memories congruent with their current mood faster than those incongruent with their mood. Most puzzling for the cognitive theories are the asymmetrical effects of mood-congruency on memory (Parrott, 1991). Mood-congruent memory has been observed more often with positive affect than with negative affect (Fitzgerald, 1989; Salovey & Singer, 1989; Varner & Ellis, 1998). In a lexical decision-task, positive affect facilitated processing of positive words but parallel effects with negative affect were not observed (Challis & Krane, 1988). These asymmetrical observations appear to follow the Pollyanna Principle mentioned earlier.

Also puzzling for mood-congruent memory, are the various conditions under which mood-congruency is less likely to be observed. For example, mood-congruent retrieval is more evident with recent autobiographical memories than with childhood memories (Salovey & Singer, 1989). This is probably because

childhood memories are so well integrated in memory that their recall is effortless and may therefore be more resistant to mood effects (Ellis & Ashbrook, 1989). Mood-congruent memory is also absent for semantic tasks indicating the importance of the episodic nature of affective material in mood-congruency (Weaver & McNeill, 1993). Mood-congruency is also more evident with implicit tasks (Bradley, 1994) as well as with self-generated autobiographical recall material rather than with experimentally determined material (Bullington, 1990). Interestingly, with naturally occurring moods such as receiving a good grade on an exam or being out on a sunny day, mood-incongruency rather than mood-congruency has sometimes been observed (Parrott & Sabini, 1990). This might explain why mood-congruency is observed only when subjects are aware of the relevance of their mood states to the experiment (Parrott & Sabini, 1990; Perrig & Perrig, 1988; Weaver & McNeill, 1992).

These observations strongly point to the contributing role of demand characteristics in mood-congruent memory, but experiments with simulators without any classic mood-inductions indicate that the phenomenon is not entirely explicable through demand characteristics (Bullington, 1990). Individual differences do, however, play a pivotal role in the phenomenon (Clark, 1989; Seidlitz & Diener, 1993). For example, women show more mood-congruency than men do (Clark & Teasdale, 1985; Ellis & Ashbrook, 1989). Depressed individuals have been found to have either a negative mood-congruency bias (Bradley & Mogg, 1994; Bradley, Mogg & Williams, 1993; Johnson & Magaro, 1987; Josephson, Singer & Salovey, 1996; Watkins, Vache, Verney, Mathews & Muller, 1996) or an absence of the usual positive response bias found in controls (Fitzgerald, Salde & Lawrence, 1988; Gilboa, Roberts & Gotlib, 1997; Richards & Whittaker, 1990). Gender and personality trait variations with regards to mood are but two of many more examples of individual differences in mood-

congruency memory phenomena.

In summary, it appears that mood-congruent memory is a relatively stable and robust phenomenon, albeit with some specific methodological constraints. At least with regards to mood-congruency, the network theory of affect and memory appears to be tenable. In the next section, the evidence for mood-dependent memory will be reviewed.

Unlike mood-congruency, there is very poor support for mood-dependent memory (Balch, Myers & Papotto, 1999; Blaney, 1986; Bower & Mayer, 1989; Haaga, 1989; Kihlstrom, 1989; Ucros, 1989). Few researchers find that mood can be used as an effective retrieval cue (e.g., Philpot & Madonna, 1993). Indeed, mood as a contextual cue appears to facilitate memory only when no other cues are available for subjects (Eich, 1995; Fiedler & Stroehm, 1986; Kihlstrom, 1989; Riskind, 1989; Smith, 1995). Indeed, in the rare occasions that mood-dependent memory is observed, it is exclusively in the context of free recall tasks (Bower, 1981; Kihlstrom, 1989; Mandler, 1992; Ucros, 1989) as well as in the presence of multiple as opposed to single word lists (Bower, 1981). This is most probably due to the fact that for more difficult tasks, subjects resort to any available cue including affective ones that can help them retrieve the desired material. Mood-dependent memory is also more likely to be observed when mood-induction is done through either self-generated material (Beck & McBee, 1995; Eich & Metcalfe, 1989) or naturally-occurring moods (Ucros, 1989). This is undoubtedly due to the fact that these more natural mood-induction techniques are more effective mood-inducers than experimentally-determined techniques (Costanzo & Hasher, 1989). Interestingly, the asymmetrical observations with mood-congruent memory mentioned earlier are also seen with mood-dependent memory, in that the latter phenomenon is more evident with positive than negative material (Ucros, 1989). Also interesting to

note is that mood-congruency appears to underlie mood-dependency effects since the best recall within mood-dependent memory is for mood-congruent material (Lewis & Williams, 1989).

In summary, the evidence for mood-dependent memory is not as supportive as it is for mood-congruent memory, but the fact that mood can still be used as an effective contextual cue for memory, given a number of specific contextual situations, allows some support of the network theory. The next paragraphs will review the evidence for the resource allocation theory.

The resource allocation model essentially predicts that emotional states impair memory performance because they use up attentional resources. There is some evidence to support these claims. The memory performance of individuals found to be depressed has been shown to be impaired suggesting that depression uses up attentional capacity (Johnson & Magaro, 1987; Watts, Morris & MacLeod, 1987). Some researchers have even found that non-clinical negative affect can be detrimental to memory (Leichtman et al., 1992), while others have found that negative affect increases the number of trials required to reach automatization but without compromising memorial accuracy (Versace, Monteil & Mailhot, 1993). Contrary to the predictions of the model, however, few researchers find positive affect to hinder memory. Positive affect has actually been observed to be quite beneficial for recall (Chebat, Gelinas-Chebat, Vaninski & Filiatrault, 1995; Eich, 1995). Indeed, positivity is argued to be a motivating force for subjects (Leichtman et al., 1992). Nevertheless, some researchers have found arousing positive material (e.g., pornographic material) damaging to later recall (Leichtman et al., 1992). These contrasting results are undoubtedly due to the intensity of affect, since increases in affective arousal appear to tax the attentional system. Arousal effects on memory will be discussed in greater detail in the next section. It appears, therefore, that the resource allocation model is

supported by the paucity of data available, although negative rather than positive emotions are primarily responsible for taxing the memory system.

A closer look at the literature on the specific effects of positive and negative affect will shed more light on the differing impacts of the valence of mood on memory. To this effect, the motivational perspective mentioned earlier will be examined. There are mainly three sets of predictions ensuing from this perspective. First, positive affect is theorized to lead to less extensive processing of environmental material and therefore more suggestibility effects. Commensurate with the carefree nature of positivity, it also leads subjects to more risk-taking behavior. Second, negative affect is predicted to lead to careful scrutiny of the environment, more vigilance and thus more immunity from suggestibility. Third, intensely emotional events are postulated to empower the attentional system. By the same token, negative stimuli are likely to be processed faster and more automatically.

A great deal of research evidence supports these various claims. Positive affect leads to less careful scrutiny of material. In marketing research, for example, positive affect leads to a positive attitude toward product (i.e., mood-congruency) regardless of product arguments (Sujan, Bettman & Baumgartner, 1993). Also indicative of less effortful processing, positive affect leads to better recall of typical targets whereas negative affect leads to better recall of atypical ones (Forgas, 1992). Specifically, positive affect has been argued to reduce task-relevant vigilance since subjects' superior performance on a secondary task is counteracted by their poor performance on the main task, only under conditions of positive affect (Seta, Hayes & Seta, 1994). There is also evidence supporting the claim that positive affect motivates subjects to take more risks. Positive affect, for example, although beneficial for recall (Eich, 1995; Chebat et al., 1995; Leichtman et al., 1992) leads to increased false alarms in recognition

memory (Morel, 1991). On the other hand, negative affect, and specifically depression, leads to a more conservative response set (Johnson & Magaro, 1987) and to slower reaction times in recognition memory (Gunther, Ferraro & Kirchner, 1996).

In parallel with these observations, many social psychologists have applied Loftus' work on suggestibility to the area of impression formation with regards to central information. The ensuing evidence indicates that positive affect enhances constructive memory biases, especially for negative information (Fiedler, Asbeck & Nickel, 1991). Typically in these experiments, subjects read ambiguous descriptions of target persons under positive or negative mood, are then asked about the applicability of desirable and undesirable personality traits and finally rate the likeability of the target. The results indicate that if the person is described as an extravert, for example, later questioning about arrogance may lead to unfavorable ratings, even if subjects felt arrogance was not descriptive of the target. Positive affect appears to render people more vulnerable to such suggestibility effects. The increased susceptibility to negative suggestions is presumably due to the higher diagnosticity of negative information (Fiedler et al., 1991). In diverted attention, however, this recall advantage of impression-incongruent information in positive affect disappears (Asuncion & Lam, 1995), lending support to the resource allocation model that emotional states, both positive and negative, utilize attentional capacity.

Also in line with the motivational model, negative information appears to signal survival instincts in that such material is more likely to be processed automatically (Lang et al., 1995). Recognition for negative stimuli, for example, is faster than for positive material (Reeves, Newhagen, Maibach, Basil & Kurz, 1991). Interestingly, stimuli are even recognized faster if they are preceded by negative information. As the motivational model would predict, negativity appears

to empower the system to process information faster and preempts subjects to be more vigilant to their environment (Reeves et al., 1991). Such is the claim by "flashbulb" memory adherents who claim that characteristics inherent in emotional events render them highly memorable. The theory also accounts for poor memory under stressful conditions, since too much stress can tax the attentional system (Leichtman et al., 1992). The model reveals its potential weakness, here, in accounting for both negative and positive results. There is, of course, evidence for both sets of arguments, that arousal sometimes aids and sometimes hinders memory. The non-falsiability of the model renders it difficult to evaluate in light of the evidence.

In summary, the evidence on mood and memory appears supportive of both the cognitive and motivational approach. The methodological variability, however, that characterizes the field, renders any generalizations about the effects of mood on memory difficult. First, experimental mood-induction techniques range from the use of self-evaluative or devaluative statements known as the Velten method, the use of hypnosis (see McConkey, 1989), the experience of success/failure, the use of affective music, the elicitation of autobiographical memories (see Baker & Guttfreund, 1993) and facial posturing. As well, the type of material to be learned varies from affectively laden material, meaningful versus fragmented material to non-effortful versus more difficult stimuli. Each of these methodological variations produces differing results that need to be accounted for within an integrated multidimensional viewpoint on affect and memory.

Other important methodological considerations make it difficult to reach generalized conclusions about the area. For example, in the current literature, there is a lack of specificity as to which mood is being induced or manipulated (Ingram, 1989). Also, the timing of the mood induction (e.g., encoding, and

retrieval) needs to be taken into account since encoding seems to be most vulnerable to mood effects. Similarly, most mood effects on memory are limited to free recall tasks and generally disappear during recognition tasks (e.g., Fiedler & Stroehm, 1986) which suggests that task difficulty increases vulnerability to mood variations. Gender and other individual differences with regards to processing of different content material render generalizations even more difficult. Women, for example, have a difficult time processing technical material when depressed whereas their performance on fairy tales is unaffected by their mood. For men, this pattern reverses (Ellis & Ashbrook, 1989).

Given all these methodological considerations, the motivational approach appears to be a more comprehensive guide to explaining the differential effects of mood on memory, while still not rejecting the claims of the cognitive model. The two models can best be conceptualized as complementary to one another. Such an integrated theory can account for mood-congruent and mood-dependent memory phenomena, as well as the asymmetrical mood observations within them. More importantly, the theory ascribes motivational forces for how individuals store emotional events of varying survival significance. The following sections review the literature on arousal and memory in order to gain a better understanding of how highly intense emotional events are stored in memory.

Arousal and Memory

The above review clearly indicates the need to examine the effects of specific emotions on memory since no generalizations can be drawn about mood's overall effects on memory. Most germane to the discussion on eyewitness testimonies is the intensity characteristic of affect and its impact on memorial accuracy. As the earlier theoretical discussion indicated, it is truly by studying the effects of arousal that we can gain an understanding of the

motivational forces guiding the inner workings of our memories during emotional events.

Indeed, intensity of affect seems to be the key factor in teasing apart the differential impacts of mood on memory (Kihlstrom, 1989). Many have argued that the unreliable findings in the mood and affect literature might very well be due to ramped confounds between affect and arousal (Mandler, 1992; Revelle & Loftus, 1992). Many researchers find that arousal actually amplifies all memory phenomena (Bryant, 1993; Clark, Milberg & Ross, 1983; Fiedler & Stroehm, 1986). There is evidence to suggest, for example, that memory congruency and state-dependent effects are sometimes intensified under arousing manipulations (e.g., exercise or pornographic stimuli) (Clark et al., 1983). Also, the memory advantage for self-describing adjectives is more pronounced with various forms of physiological arousal (e.g., exercise) (Baron & More, 1987).

This amplification of phenomena under arousing conditions extends well beyond the context of memory processes. The fact that subjects' attitudes improve following positive feedback is an effect which intensifies with arousal (i.e., exercise) (Clark et al., 1983). Even the observation that positive affect encourages more risk-taking behavior is amplified under various conditions of arousal. Such was the case in Dutton and Aron's (1974) famous interview of subjects on a suspension bridge where they observed that such a fear-arousing context increased the number of subjects who asked the opposite-sex confederates out on a date. The following sections will review the effects of arousal on memory phenomena in general. As the earlier sections showed, the various memory phenomena, especially in relation to affect, can be subject to considerable debate and controversy and one's conclusions depend on what interpretive hat one imposes on the data and what set of data one focuses on.

The cognitive perspective reviewed earlier with respect to affect and

memory has been extended to the area of arousal's effects on memory. When applied to arousal, the network and the resource allocation model predict contradictory effects for memorial accuracy. The predictions of the former translate succinctly into the intensity principle which states that arousing stimuli are remembered better, regardless of the valence of the material (Bradley, 1994). The resource allocation model predicts that arousal or stress generally and indiscriminately inhibits memory because arousal requires attentional resources. The theoretical solution for these opposing viewpoints has been the Yerkes-Dodson Law which predicts an inverted-U shape relationship between arousal levels and memorial performance (Deffenbacher, 1983). Briefly stated, it claims that for every type of task performance there is an optimum level of arousal.

In a review of the literature, Deffenbacher (1983) concluded that some optimal level of arousal was actually conducive to memory improvement. He reviews a total of 21 studies and finds that half of them found beneficial memory effects for arousal and the other half found arousal to be detrimental to memory, depending on the intensity level of the arousal. Of course, the arbitrariness with which one can define optimum levels of arousal (Revelle & Loftus, 1992) weakens the theory somewhat. In addition, the fact that the theory accounts for both positive and negative results renders it non-falsifiable (Anderson, 1993). The evidence regarding arousal and its effects on memorial accuracy paints indeed a complex picture of variables and contextual manipulations that do sometimes reveal beneficial memory effects for arousal and sometimes detrimental memory effects for arousal. The two opposing arguments that arousal or stress inhibits memory but that the intensity of stimuli render them more memorable, appear to both hold some truth. The following sections will review these two sets of evidence in an attempt to gain a better understanding of

the mechanisms at work here.

Arousal improves memory:

With regards to arousal's positive effects on memory, there is indeed ample evidence to suggest that memory benefits significantly from arousing manipulations. It seems that even for boring or relatively easy tasks, arousal actually improves memory. Noise rather than no noise improves face recognition during more upsetting rather than less upsetting staged incidents (Deffenbacher, 1983). Hosch and Cooper (1982) also found that the presence of a crime rather than no crime but equally memorable encounter with a confederate improved participants' face recognition on a photo-spread. This is especially true for incidental learning since forewarning subjects about nature of the to be remembered (TBR) material nulls the effect (Deffenbacher, 1983; Shaw et al., 1995). This suggests that the phenomenon is probably due to more automatic hard-wired reactions, reminiscent of the motivational theory described earlier. Indeed, a memory system sensitive to arousal is a good survival tool because intense actions might be related to preservative and protective behaviors (Bradley, Greenwald, Petry & Lang, 1992).

Furthermore, the beneficial effects of arousal are not by any means limited to face recognition. Even when arousal has been operationalized as colored pictures, it was found to lead to better memory after a delay of seven days (Farley & Grant, 1976). In their study of arousing pictorial and auditory stimuli, Bradley and her colleagues (Bradley, 1994; Bradley et al., 1992) found arousal to have a facilitatory effect on memory, since both negative and positive arousing stimuli resulted in memory improvement, in both free recall and recognition tasks. Interestingly, with regards to retention intervals, material valence and task difficulty, they found a slight advantage for pleasant stimuli on

immediate recall whereas recognition showed an overall advantage for unpleasant stimuli. This observation might reflect a natural memory bias toward positivity (Thomas & Diener, 1990) on immediate recall whereas the higher diagnosticity of negative information reveals itself in the facilitated recognition for unpleasant information after a delay (Fiedler et al., 1991).

Similarly, Lang et al. (1995) found that arousing messages were remembered better than calming messages. In this study as well, the valence of the material did interact with retention intervals in that positive messages were remembered better than negative ones when memorability was assessed immediately after presentation of the messages. As a matter of fact, subjects had slower reaction times for a secondary task during the presentation of the positive messages. This suggests that they were either allocating more attentional resources to positive stimuli than to negative stimuli or that the negative stimuli are processed more automatically because of their higher probability in signaling survival information. In trying to tease apart these effects, Bradley and her colleagues (Bradley et al., 1992) conducted a study in which they looked at both arousal characteristics as well as pleasant and unpleasant valence of stimuli in relation to retention interval. They found indeed that pleasant information was remembered best upon immediate recall whereas after a delay, arousing stimuli whether positive or negative promoted the best retention performance. Other researchers have more recently confirmed these observations (Parent, Varnhagen & Gold, 1999).

These findings indicate more and more stipulations for the seeming robustness of the beneficial effects of arousal on memory. The studies that do find memory improvement under emotional conditions are limited to those which focus on central features of events and usually for long-term retrieval (i.e., a day or more) (e.g., Christianson & Loftus, 1991; Heuer & Reisberg, 1990; 1992;

Mandler, 1992; 1993). Therefore, it appears more accurate to state that arousal biases memory processes. Namely, emotional events tend to benefit memory for some kinds of information to the detriment of others. At very high levels of arousal or emotional stress, for example, Easterbrook (1959) has convincingly proposed that there is a progressive restriction of the range of cues utilized as a result of intense emotion. This narrowing of attention tends to increase memorial accuracy for some stimuli and to decrease it for others, depending on the difficulty of the task at hand and of course the intensity of arousal (Easterbrook, 1959). Essentially, researchers have argued (e.g., Mandler, 1993) that increased levels of arousal improve memory for central information such as a threatening weapon and are detrimental to memory for peripheral information.

Of course, the lack of clear operationalization between what is meant by central information versus peripheral (Heuer & Reisberg, 1992; Mandler, 1993) and levels of arousal (Revelle & Loftus, 1992) renders the Easterbrook claim or the weapon focus as it is popularly referred to, quite problematic to verify empirically. Despite these problems in clear operationalization, researchers have ventured to find considerable supporting evidence for the weapon focus. In one study, subjects who were taking tests while a confederate walked in with a syringe, had less memory of the confederate's face than characteristics of the syringe, as compared to a control group (Heuer & Reisberg, 1992). In another study where subjects either viewed a man hand a check to a cashier and receive cash or point a gun at her and receive cash, Christianson and his colleagues (Christianson, Loftus, Hoffman & Loftus, 1991) found subjects looked more at the gun than the check. Since it is experimentally known that isolating a stimulus from others makes it more memorable (Christianson, Goodman & Loftus, 1992), the experimenters went on to dismiss the possibility that the "weapon focus" effect could be explained by the distinctiveness or unusualness of the "weapon".

In addition to viewing a man either point a gun or hand a check to the cashier, one group of subjects actually saw him point a banana and receive money from her. Despite the unusual nature of both stimuli, the gun still received more viewing attention than the check or the banana.

More recently, Safer and his colleagues (Safer, Christianson, Autry & Oesterlund, 1998) found direct evidence for the "weapon focus" and the proposed restriction of cues utilized in later memory recall. They defined arousal as the viewing of traumatic slides and found that subjects remembered the critical information in the slide as more focused spatially than in its original presentation. This visual restriction of the boundaries of the emotion-arousing slide supports the idea that the critical elements of the arousing stimuli benefit from more elaborated processing by subjects overall and this leads to improved memory for these items.

However, despite the implications of these studies, even increased levels of rehearsal and attention that the "weapon" usually benefits from such situations are not enough to explain the phenomenon. Indeed, despite various experimental manipulations that compelled participants to focus equally on arousing and neutral TBR material (Heuer & Reisberg, 1990), volunteers in the aroused condition still had the best recall performance. In another recent innovative study, Christianson and Loftus (1991) again tested the distinctiveness hypothesis and the claim that central information benefit from arousal levels. They presented four types of slides to subjects: a woman injured beside a bike, a woman carrying a bike upside down, and a woman riding a bike. Their results revealed that with regards to central information, the emotionally aroused group had the best recall performance, whereas with regards to peripheral information, the neutral slide engendered the best recall performance. In recognition tasks, however, all these differences disappeared. The unusual slide with the woman

carrying the bike upside down produced particularly poor memory performance. This study as well as others like it (e.g., Loftus & Burns, 1982) lends little support to the distinctiveness variable. The emotion engendered by arousing material appears to be qualitatively different from elaboration of non-affective material. There appear to be inherent characteristics in the arousing or emotional stimuli that magically contribute to increased memorability. Unmasking the sum and substance of this "magical" process is the core of the present study.

One of the only negative pieces of evidence for the Easterbrook claim is an interesting study of long-term memory (i.e., two weeks) by Heuer and Reisberg (1990). Contrary to the claim that arousal leads to a narrowing of attention, they found that it actually led to better recall of both central and peripheral information. However, a number of methodological problems render this conclusion doubtful. For example, the arousal and neutral versions of the slide presentation could easily be criticized for problems of comparability. In both versions, a mother takes her son to see his father at work. In the arousal condition, the father is a doctor and subjects see slides of a surgery and in the other, he is a mechanic and is repairing a car. These two versions of the slides do not allow us to distinguish between arousal and interest levels in subjects.

Despite the generally supporting evidence for the weapon focus, much debate surrounds what delineates central from peripheral features of an event. Heuer and Reisberg (1992) have proposed one definition that states that peripheral aspects are details that can be changed without changing the event's identity at a basic level. Central information, on the other hand, concerns more the who, what, where and when aspects of the event. More specifically, Burke, Heuer and Reisberg (1992) successfully teased apart what aspects of central and peripheral information are differentially affected by arousal levels. They not only looked at central and detailed information as dependent variables but also

further subdivided central features into either "gist" information or items of basic level importance. They also differentiated detailed information further into details of central characters (e.g., such as shirt color of central character) and details of background (e.g., such as color of a passing car).

In this study, arousal levels were found to improve recall of all information tied with central aspects of the story (including details) but were found to be detrimental for details of background. Interestingly, arousal level also decreased memory for details of central aspects *temporally* removed from arousal. In other words, the relative memory advantage of arousal on details of central aspects is only revealed in the phase where the emotion is introduced. It seems therefore that arousal does narrow attention to central aspects including details but to the detriment of what preceded and followed the arousing event (Heuer & Reisberg, 1992). Bornstein and his colleagues (Bornstein, Liebel & Scarberry, 1998) replicated these findings more recently. Interestingly, they found that repeated testing over time alleviated some of the memory impairment but also led to an increase in memory intrusions. The only negative result for this phenomenon in the literature is a study by Warren and Harris (1975) who found good memory for both immediate and delayed recall. In their study, however, delayed recall was only 45 minutes after the presentation of the stimuli and there is evidence to suggest that at least one hour needs to elapse before long-term memory processes begin to work (e.g., Christianson et al., 1992; Lavach, 1973).

In addition to arousal levels biasing the kinds of information that benefit from higher memorability (i.e., central aspects of an event), arousal levels also promote long-term as opposed to immediate memory processes. Indeed, several researchers (e.g., Burke et al., 1992; Millar, Styles & Wastell, 1980) have found that arousing situations usually lead to better memory performance after a considerable delay (e.g., over a day). Lavach (1973) found high-arousing words

in a 20-minute lecture were remembered twice as often during long-term retrieval (i.e., more than a day) whereas low-arousal words were remembered much better on short-term retrieval (i.e., one hour or less). It is important to note, however, that despite these results, subjects from both groups experienced extensive forgetting. Equally interesting to note are the observations made by some researchers (e.g., Burke et al., 1992;Heuer & Reisberg, 1992; Pillemer, 1984) that memory tested for a second time after a delay is quite different from memory tested for the first time after a delay. It seems that an initial memory test works as a rehearsal technique, improving memory performance in a second testing session.

The fact that arousal biases memory and encourages memorability for some stimuli for specific retention intervals, also means that arousal modulates memory with regards to the kinds of errors subjects commit. Heuer and Reisberg (1990), for example, found that the errors of their aroused subjects revolved mainly around ascribing false motives and emotional reactions to characters as well as making false overinterpretations with regards to slides. A field study by Yuille and Cutshall (1986) revealed that about half of memory errors committed by subject witnesses of an actual crime were related to the action of the event. Another 40 percent of errors were related to descriptions of people and very few errors were made about objects. One subject for example, intricately described the wounds on a body but made several errors about what the person was wearing. These observations are quite consistent with the weapon focus perspective but signal a potentially dangerous role for arousal and commission of errors of memory, especially in the context of eyewitness testimonies.

To add even further complexity to matters, the majority of studies that do find beneficial effects for arousal for long-term memory with regards to central features of an event, are usually also limited to recall tasks exclusively. Generally

speaking, recognition tasks are relatively immune to the effects of arousal (Cahill & McGaugh, 1995; Christianson & Loftus, 1991; Christianson & Nilsson, 1989, Mandler, 1993). Some researchers (e.g., Heuer & Reisberg, 1990), however, have found no differentiating effects for arousal on recall or recognition, concluding that arousal is universally beneficial for memory tested in any manner. One reason for such discrepant findings might be the absence of any misleading questions in the recognition task of these studies. Indeed, arousal has been shown to lead to faster recognition performance but only when foils differ markedly from targets. As foils resemble targets more and more, recognition performance under arousing conditions easily deteriorates (Bradley, 1994; Brown, 1995). Therefore, an important consideration for any well-designed study of arousal on memory must include both free recall and recognition tasks.

All these contextual stipulations seem to suggest that not only is arousal not beneficial for memory but it may actually be hindering it. This brings us to the second set of data, which reveals arousing or stressful situations to be generally detrimental to memory (e.g., Bradley, 1994; Christianson & Nilsson, 1989; Deffenbacher, 1983; Loftus & Burns, 1982).

Arousal hinders memory:

The important factor seems to be that stressful events reduce accuracy with regards to peripheral detail more than non-stressful ones (Deffenbacher, 1983). Overall, the literature shows retrograde loss of detailed information (Kebeck & Lohaus, 1986), especially for short-term retrieval of less than one hour, as well as anterograde recall decrements following trauma (Heuer & Reisberg, 1992; Loftus & Burns, 1982; Mandler, 1993). Loftus and Burns (1982) for example, showed that a violent version of a movie can cause amnesia for information presented just prior to the violent episode. This effect was found

regardless of whether memory was tested by recall or recognition. These observations stand in direct contrast to the Von Restorff phenomenon and suggest an important role for the affective component in the stimuli that powerfully counteracts any effects of distinctiveness. This affective component may actually work to attenuate memorability of emotional stimuli and surrounding ones as well.

This line of evidence relates to reports that stress and panic under highly arousing conditions can sometimes prevent adequate problem solving (Mandler, 1993). For example, case reports reveal that people often revert back to stereotyped behaviors and simpler modes of problem-solving, such as pursuing failing solutions, at times of panic. Drawing the parallel in the context of memory, it may be argued that arousing situations can actually prevent adequate memory encoding. In support for such a claim, Christianson, Nilsson, Mjorndal, Perris and Tjellden's (1984) study showed that the viewing of mutilated faces among other stimuli caused a memory deficit for verbal descriptors associated with the faces. Even the finding that arousal benefits long-term retrieval has not always been replicated by researchers. Saufley and LaCava (1977) for example, failed to find beneficial effects for arousal on long-term memory. Therefore, another important consideration for a well-designed study of arousal on memory is to include both short-term and long-term retention intervals.

Also, MacWhinney, Keenan and Reinke (1982) found that emotional content was not a good predictor of long-term memorability of natural conversation. In this study, however, the experimenters had an unusual operationalization of emotional content. They defined it as high-interactional sentences, namely those that conveyed aspects of a person's beliefs or feelings. On the other hand, low-interactional sentences are those, which convey aspects that, are tangible verifiable facts. A study of over 200 children failed to find any

facilitatory effects for arousal during the viewing of a two and half minute videofilm of an argument between a teacher and a student, both immediately and 14 days later (Kebeck & Lohaus, 1986). As a matter of fact, the arousal group showed lower recall performance than the neutral group. It is important to note that the results did suggest that the memory detriment observed may have been due to peripheral information being less well remembered by the arousal group.

The detrimental effects of arousal on memory are rampant in the literature and appear to be found with very disparate operationalizations of arousal. In two separate experiments, for example, Folkard (1979) operationalized arousal as either muscle tension while carrying out a memory task or as time of day for testing. In both experiments, results revealed that regardless of the operationalization, arousal deteriorated memory performance for digits. It was argued that arousal hindered memory because it used attentional resources in a similar fashion than groups who were instructed to perform other vocalization tasks. Others (e.g., Shaw et al., 1995) tested memory for high and low imagery words while subjects were either aroused by seeing violent segments of movies or calm by viewing a bird-nesting videotape. Results revealed that arousal interfered with the usual hypermnesia found for high imagery words. More recently, arousal defined as caffeine intake failed to produce any beneficial effects on an incidental memory task (Herz, 1999).

Similarly, Hollin (1984) found that arousal in the form of white noise introduced just prior to the appearance of a man interfered with subjects' recognition capacity for the man. Geen (1973), for example, induced arousal in subjects by informing them that they were being observed during a memory task. Results revealed that the performance of those being observed was poorer on short-term memory but better on long-term memory than of those not being observed. Interestingly, it did not matter whether the experimenter was physically

in the testing room or not, as long as subjects believed they were being observed by videocamera. More recently, Bushman (1998) examined the effects of television violence (i.e., arousal) on the memory of commercials interspersed between the violent film clips. He found arousal to be detrimental to the memory of the commercials. Even the pace with which the to be remembered messages are displayed appears to mediate the effects of arousal. Some researchers (Lang, Bolls, Potter & Kawahara, 1999) for example found that arousing content impaired memory for videotaped messages only when it was combined with a fast pace of presentation.

Resolution of discrepant findings:

The question now is how do we resolve these two sets of contradictory evidence: one strongly supporting the beneficial effects of arousal on memory and the other impressively revealing the detrimental effects of arousal. From the above review, it is not at all clear whether arousal helps or hinders memory. It does seem clear that arousal has biasing effects on the memorability of certain stimuli in specific situations. Yet such a conclusion fails to resolve the two disparate sets of evidence. After all, on the one hand, arousal appears to raise recall memorability of central features of an event, especially after a relatively long delay. On the other, the evidence fails to regularly replicate these results and finds instead that arousal hinders memorability. One argument that has been put forth to explain these discrepancies is the lack of ecological validity inherent in laboratory controlled experiments of arousal. Indeed, there is considerable debate in the area about the generalizability of pseudomemory research.

Many theorists argue that such controlled laboratory experiments do not apply to the clinical trauma therapy situation (Brown, 1995). They argue that the personal impact of the emotional event contributes significantly to increased

memorability of that event and since one cannot ethically replicate events of significant personal impact in the lab setting, one cannot generalize passively watching a robbery on a videoclip to being a victim of a serious crime (Yuille & Tollestrup, 1992). On a theoretical level, Conway and Bekerian (1988) have argued that the personal relevance and consequentiality of events relate directly to their vividness. In support for such claims, there is evidence to suggest that the presence of a crime versus an equally memorable but non-criminal encounter improves identification accuracy (Hosch & Cooper, 1982). However, contrary to the personal impact claim, whether subjects were personally victims of a theft or simply witnesses to the impersonal theft of a calculator had no impact on identification of the culprit (i.e., in this study, face recognition was 37 and 52 percent respectively). Perhaps the anxiety and arousal of the situation counteracted the benefits of increased attentiveness (Christianson et al., 1992).

Other contradictory evidence for the personal impact claim comes from clinical reports of crimes which often state that witnesses of robberies remember events better than victims of more personal crimes such as rapes or incest (Brown, 1995; Christianson et al., 1992). It appears that memory for traumatic events also follows an inverted-U shape, depending on the intensity of the personal impact of the emotional event. That is, given an optimal level of emotionality, memory for relatively stressful events is good. Beyond or below that level, memory for both non-stressful and highly stressful events is poor. Furthermore, with increasing stressful situations, rates of false beliefs increase with longer retention intervals and multiple interrogations (Brown, 1995). The personal impact argument relates directly to studies of the flashbulb memory process. The argument in both contexts is that characteristics inherent in the emotional traumatic stimuli themselves and their significant consequentiality contribute directly to their increased memory. Whether the existing evidence is

supportive of this assumption, however, is a matter of great debate. A brief review of some of the studies of flashbulb memories seems warranted to clarify this issue.

In the context of flashbulb memories, there are two opposing viewpoints about how strong emotions affect memorability. The first is the "now print" theory of Brown and Kulik (1977) who argue that flashbulb memories are processed by the limbic system, which results in an intact recall of the event (also see Van der Kolk, 1993). The second theory is the "reconstructive script" by Neisser and colleagues (Neisser & Harsch, 1993) who claims that the emotional component of these remarkable events affects memory by encouraging rehearsal and reconstructive processes fueled by our need to develop a coherent story. Unfortunately, studies of flashbulb memories generally look for stability and consistency of memory and can rarely study memory accuracy (Bohannon, 1988; Heuer & Reisberg, 1992). They generally find that information is relatively consistent over time (i.e., 62-90 percent consistency over the course of 9-12 months) with regards to central features (i.e., when, what, who, where, etc.) but that with the passage of time, information production declines, especially with regards to detailed information (Christianson, 1989). Thus, the flashbulb memory information does decay over time but more slowly than that for other autobiographical memories (Christianson, 1989).

Indeed, an interview of over 200 subjects revealed that the memory of a traumatic autobiographical memory is usually quite old (i.e., over 1 year), and has often been rehearsed repeatedly (Christianson & Loftus, 1990). Interestingly, over 80 percent of subjects interviewed remembered at least one striking detail but most of the information recalled was central in nature. The reconstructive and the now print theories of emotional memories appear to both hold some truth, although the evidence seems more compatible with a reconstructive viewpoint.

The few flashbulb studies that have looked at the relationship of emotional reaction and memorability have found an association between emotionality and memory elaboration (Christianson, 1989; Pillemer, 1984) and sometimes even a relationship between emotionality and memory consistency over time (Pillemer, 1984). But unfortunately, information consistency or reliability gives no indication of the accuracy of the information. McCloskey, Wible and Cohen (1988) resumed it best when they argued that there is no special flashbulb memory mechanism and that flashbulbs are no more immune to reconstructive memory processes than other autobiographical memories. They are at best more memorable autobiographical memories (see Neisser & Harsch, 1993).

Since none of the information gathered through flashbulb memory studies can be independently corroborated, any derived conclusions are on shaky ground. In one of the only field studies where corroboration was possible, Yuille and Cutshall (1986) conducted extensive interviews of 13 witnesses to an actual crime for which extensive forensic information was available. Verification for some of the subjects' statements was therefore possible. The average accuracy rate in these interviews was an impressive 79% and yet 23% of subjects still reported non-existent events without any prompting. Little is known, however, about the extent to which subjects could report false beliefs if misleading questions were asked of them. Furthermore, the experimenters not only dismissed all expressions of uncertainty from the subjects but they were also not blind about the events that had taken place. It is certainly much easier to have subjects report events correctly when the leading questions are all correct. The situation might have been very different if interviewers who ignored the facts and were trying to use subjects' statements to arrive at the protocol of the events were questioning witnesses. In such a situation, many more assumptions and interpretations by interrogators could give rise to misguided questioning that may

then lead to false reports from interviewees. On the other hand, the striking nature of the event as well as the repeated renditions of the events to the police and experimenters can be at the basis of such an excellent retention level in this case study. The lack of a control group strongly limits any conclusions we can reach.

It is important to note that despite the evidence that arousal may slow forgetting through physiological mechanisms as well as rehearsal techniques and distinctiveness, significant memory decay still takes place (Heuer & Reisberg, 1992). In an interesting study that combined lab controls in a natural setting, Peters (1988) asked 212 subjects who had recently been given an injection to identify the nurse giving the injection or a researcher met after the injection. The results revealed that the stress of the immunization shot impaired memory for the nurse as compared to the researcher. Recognition rates for the former were 41 percent and for the latter 66 percent. Interestingly, however, in target-absent lineups, there were between 35-44 percent false alarms, signaling once again the potentially dangerous effects of arousal on memorial fallibility. The apparent discrepancy between field studies and lab experiments has been argued to be due to differential focus points. The first set of studies (Christianson et al., 1992) focus on reliability and stability of memory while the second set of experiments focus on errors and memory decline .

Therefore, the argument of ecological validity is not a tenable claim to dismiss all the findings of the experimental studies. Moviemakers of all times have proved that affective simulation works successfully with the majority of people in a relatively controlled setting (Christianson et al., 1992). Even if one cannot ethically simulate movies' extreme arousal levels in the laboratory, certainly all the experiments conducted on arousal and memory reveal invaluable information about memory and help unmask all the mysteries surrounding it.

Nonetheless, the blaring discrepancy between the two sets of evidence regarding the impact of arousal on memory poses not only an interesting theoretical dilemma but also demands a sound resolution if one is to reach meaningful conclusions about the field.

Part of the explanation for these discrepant results comes from failures to tease apart type of information recalled into either gist or detailed information. Also, it is important to recognize the role that retention intervals play in moderating arousal's impact on memory. Despite these various considerations, however, glaring discrepancies about arousal's effects on memory still remain. In closely viewing the two sets of data, one plausible hypothesis concerns the difference between memory of affective stimuli and memory of neutral stimuli while in an emotional state. It does appear that more detrimental effects of arousal on memory appear to be often found when the arousal-inducing stimuli are not the TBR stimuli. In such cases, arousal has been induced in ways in which arousal is not part of the content of the learning task but part of the learning context.

In all the studies reviewed in the earlier sections, that had found universally beneficial effects of arousal on memory, the TBR stimuli were also the source of the arousal-learning content. Whether researchers asked subjects to identify the face of a thief (Hosch & Cooper, 1982) or to recognize arousing pictorial, auditory or narrative material (Bradley, 1994; Bradley et al., 1992; Christianson & Loftus, 1991; Farley & Grant, 1976; Heuer & Reisberg, 1990; Lang et al., 1995; Lavach, 1973), the arousal-inducing stimuli are integrally part of the content of the learning material. Even researchers of the weapon focus usually measure how well people recall the arousal-inducing stimuli such as a syringe (Heuer & Reisberg, 1990) or a gun (Christianson et al., 1991).

Researchers find arousal to hinder memory when the source of the

arousal is different from what is asked to be recalled. In such cases, arousal is more part of the learning context than an integral part of the learning material. It does seem reasonable to conclude that arousal leads to better long-term memory for gist-type information to the detriment of short-term recall of detailed information (e.g., Loftus & Burns, 1982). The hypothesis that is being proposed is that in addition to these biasing effects of arousal on memory, arousal has more hindering effects on memory when the arousing stimuli is not what subjects are asked to recall. Folkard (1979) for example, found subjects' memory for digits was hindered when they watched arousing rather than neutral stimuli. The results might have been different if subjects' memory for the arousing stimuli was being tested.

The same argument can be extended to Christianson et al. (1984) who found subjects' memory for verbal descriptors was hindered for mutilated faces. If subjects' memory for faces was being tested, perhaps arousal would have been found to have beneficial effects. The other two studies (Geen, 1973; Hollin, 1984) reviewed earlier that found arousal to have detrimental effects on memory, operationalized arousal as part of the learning context and not part of the TBR material. These studies induced an arousing state in subjects by introducing either white noise (Hollin, 1984) or by instructing subjects that they were being observed during a task performance (Geen, 1973). It seems reasonable to suggest that arousal is detrimental to all memory phenomena when it is unrelated to the meaningful content of the learning material. When it is related to the content of such material, then arousal biases memory, increasing retention for some kinds of information (i.e., gist of events) to the detriment of others and promoting long-term instead of short-term retention intervals.

The observation that arousal acts as a distractor when it is part of the context rather than the content of the learning material is not limited to the area

of memory phenomena. There is also some evidence that arousal whether operationalized as exam anxiety or white noise, results in polarization of social judgments (Paulhaus & Kim, 1994). In both conditions, arousal was externally induced and unrelated to the task at hand, that is the social judgments. It seems that under such conditions, arousal acts as a distractor to the task at hand and demotes cognitive complexity. Unfortunately, few studies have carefully and directly looked at these differences in the context of memory processes.

Different mechanisms, cognitive and physiological, appear to be at work when arousal is endogenously induced by the TBR material than when arousal is induced exogeneously by stimulant drugs for example (Heuer & Reisberg, 1992). After careful review of the literature, the evidence strongly suggests that there are intrinsic characteristics about emotional events that bias memory and promote memory in some ways and weaken it in other ways. In their review of the literature, Burke et al. (1992) quote some unpublished data that strongly suggest comparison of identical stimuli where arousal is manipulated either externally (and not related in an integral way to the story or the narrative of TBR material) or internally (through actual material) that memorability of material is quite different, poor in the former case and better in the latter.

In a typical experiment of this sort, one may ask subjects to listen to a story while sitting next to a fearful object or to simply listen to an emotionally arousing story. In other words, the argument is that memory while emotional is considerably different from memory of emotional materials. The parallel in the eyewitness context would be a passive witness to a crime versus the victim of that crime. The importance lies not only with regards to the level of personal impact of the emotional event but also whether the arousal is intrinsically and indistinguishably related to the meaning and interpretation of the narrative of the event. These variables have consistently been confounded in the literature

(Bradley, 1994) and it is only with careful scrutiny of the evidence that one can see a potentially significant role for contextual arousal versus arousal levels in the content of the TBR material.

Only a handful of published studies to date have actually directly tested this hypothesis. Cahill and McCaugh (1995) set the stage for these types of manipulations when they devised identical slides that could accommodate both an emotional interpretation of the slide sequence or a neutral one depending on the narrative used to accompany the slides. They found memory improvements only for the emotion-arousing story. More recently researchers (Libkuman, Nichols-Whitehead, Griffith & Thomas, 1999) examined whether the source of the emotional arousal actually influenced memory. Arousal was either intrinsically induced by viewing an emotional slide sequence or externally induced physiologically through exercise. Memory improvements were observed only for the condition in which arousal was intrinsically induced.

Christianson and his colleagues (Christianson et al., 1984) obtained very different results in a study where they also induced arousal either externally or internally but found that arousal caused memory deficits when its source was associated with the TBR material. In their study of cued recall, arousal was induced either externally by a stimulant drug or by the viewing of mutilated faces. In both conditions, photographs of the faces were presented with four verbal descriptors that subjects were subsequently asked to recall upon presentation of the paired photograph. The contradictory results in this study could be due to a number of factors, including shorter retention intervals used in the latter. Most likely, however, the results are due to the fact that the operationalization of intrinsic arousal in this study paralleled more that of external arousal since the arousing characteristic of the stimuli, the mutilated faces, were segmented and did not relate integrally with the meaningfulness of the content of a narrative. In

such a case, the argument is that arousal as induced by the mutilated faces worked as a distractor much as it would have if it had been induced through the physical context, such as white noise, etc. The state-dependency hypothesis for this phenomenon (Yuille & Tollestrup, 1992) is not a tenable assertion in this case.

Individual differences are another contributing variable to these disparate observations about arousal and memory. Yuille and Tollestrup (1992) talk of considerable range of differences in memorability of arousing events. About half of murderers have amnesia of their act but many serial killers remember minute details of their acts. In teasing apart these individual differences, it appears that it is not the event itself that makes it more or less memorable but the meaning of the event for the individual. In their interview of 13 witnesses to an actual crime, Yuille and Cutshall (1986) found that the subjects could be categorized in one of two groups: those who gave few details of the events, concentrating their statements on the central features of the story; and those who reported twice as many peripheral details than the earlier group. In his field study of over 200 subjects, Peters (1988) found that trait anxiety combined with the stress of an immunization situation impaired peoples' identification of the nurse administering the shot, even further.

Others have confirmed the detrimental effects of the combination of an arousing situation and both state and trait anxiety on memorial accuracy (e.g., Deffenbacher, 1983). Others (e.g., Bradley, 1994) have found subjects' neuroticism to correlate with false memories. But D'Ydewalle, Ferson and Swerts' (1985) findings suggest that neurotics may have learning strategies that best suits them for long-term memory. Bothwell, Brigham and Pigott (1987) have found that arousal has an overall debilitating effect on identification accuracy of neurotics whereas it has the opposite effect for those labeled as stables. Revelle

(1987) suggested that there is a stylistic difference in subjects' strategy preferences which directly affects their memorial performance in terms of speed and accuracy. Namely, in an arousing context, highly anxious individuals will prefer adopting a more conservative approach whereas those low on anxiety will adopt a speedier approach to performance.

With regards to individual differences, people bring stress to a situation just as the situation brings out the stress potential in people. Both a potentially threatened individual and properly interpreted situation are needed to produce stress (Mandler, 1993). In general, there is a group of subjects that is highly suggestible (i.e., individual variable) and this group of individuals become particularly vulnerable in some social contexts (i.e., social influence variable) (Brown, 1995). In his review of the literature, Deffenbacher (1983) reports that men's memory of emotional events are usually superior to that of women, especially with regards to facts about the target person. Others (e.g., Brigham et al., 1982; Deffenbacher, 1983) have shown that blacks' increased overall vigilance makes them better than whites at face recognition. Many studies done with extraversion-introversion as personality variables (e.g., D'Ydewalle et al., 1985; Gabrys, 1980; Halmiova & Sebova, 1982; Halmiova, Sebova & Voicu, 1980; Thompson & Perlini, 1998) showing that introverts usually outperform extraverts when the emphasis is on accuracy but that extraverts outperform introverts when arousing situation becomes relatively stressful.

A few researchers (e.g., Hosch & Cooper, 1982; Hosch, Leippe, Marchioni & Cooper,1984) have reliably found a substantial relation between the self-monitoring construct and eyewitness accuracy. High self-monitorers or individuals who pay careful attention to the actions of others outperform low self-monitorers on incidental learning and facial recognition tasks (Snyder, 1986). For example, Hosch et al. (1984) discovered an interaction between self-monitoring

and the personal impact of the emotional event. In their study of victimization, participants either witnessed a confederate steal the calculator of the laboratory or a personal item from the participants themselves. Individuals categorized as high self-monitorers, namely those who are particularly concerned with the social appropriateness of their behavior were better at identification when they were victims rather than just witnesses. This pattern was reversed for those low in self-monitoring who were better at identification when they were attendants rather than victims. Based on these and other results, inclusion of the self-monitoring measure seems warranted in a study of arousal and memory.

Also, because of a long-standing traditional belief that hypnotizability relates positively to memory capacity, it is appropriate to include other personality and cognitive variables found to relate to a capacity for hypnosis. Measures of a capacity for absorption and imaginative thinking were incorporated in this investigation in order to assess whether they relate in any meaningful way to memory capacity. Also, the inclusion of the Autobiographical Memory Questionnaire (Czank & Conway, 1994) was deemed valuable because it is the only current measure assessing individuals' beliefs about their memory ability. Although no normative data has been collected on this questionnaire, it is informative to explore whether there is a relation between one's beliefs in one's memory capacity and one's actual memory performance, especially in relation to arousal.

Conclusion

In summary, the literature review on memory malleability generally indicates that our memory system is relatively reliable in terms of central events but it is also easily corruptible by simple situational manipulations. This memory malleability poses a real concern in the eyewitness context. In reviewing the

literature on affect and memory, although it is clear that affect has an impact on memory, it is more difficult to decipher replicable and robust phenomena. Mood-congruency effects and the asymmetrical effects of positive versus negative mood both indicate that mood valence plays a pivotal role in memory phenomena. More importantly, however, arousal or intensity of affect appears to resolve many of the discrepancies observed in the literature. It is really the memory of emotional arousing events that is most informative of the eyewitness context.

The literature on arousal or intense affect and its impact on memory reliably predict several phenomena. First, arousal tends to increase memorability for central characteristics of an event to the detriment of peripheral details. This observation is especially true for longer retention intervals. There is also some evidence that arousal improves memorability of details of central characters of the to be remembered event as long as the events are temporally associated with the arousal. These predictions tend to be observed more frequently with free recall rather than recognition tasks.

Another theorized modulating factor in the arousal and memory phenomena is the distinction between arousal being part of the context in which memory is being tested and arousal being intricately associated with the to be remembered material. This distinction between memory while in an emotional state and memory of emotional events will be directly tested in the present experiment.

The literature also offers some evidence that individuals' cognitive and personality differences have some predictive value for their memory ability. A capacity for absorption, imagery and imaginative thinking as measured by the Tellegen's Questionnaire for absorption and the Individual Differences Questionnaire have been traditionally been found to significantly correlate with

hypnotizability. Because of this strong and robust relationship with hypnotizability, absorption and imagery could very well also relate to memorial ability. The Autobiographical Memory Questionnaire is the only measure to date of individuals' beliefs about their memory capacity. It is reasonable to investigate whether individuals' beliefs in their memorial capacity relate in any significant way to their measurable recall ability. Also, Snyder's Self-Monitoring Scale that measures individuals' awareness and concern for the social appropriateness of their behavior has been found to relate negatively with their memory of an emotional event. Although this phenomenon seemed to be more evident when the individuals were actual victims of the crime, the construct could potentially have some predictive value for memory ability. Therefore, the measures of absorption, imagery, beliefs in one's memory abilities and self-monitoring is included in this investigation of arousal and memory in an attempt to determine whether they hold any predictive value of individuals' memory retention capacity.

The present experiment

In an attempt to investigate memory in a eyewitness context, the present study sought to examine the effects of arousal on memorial accuracy. Specifically, it compared memorial accuracy under conditions where arousal was integrally part of the content of the TBR material and where arousal was only related to the physical context in which participants were present. For the present study, Cahill and McGaugh's slides were adapted to induce arousal in only one group of participants while the other groups viewed the same slides with a neutral rather than an emotional version of the story. In order to induce arousal in the physical context of participants, an audiotape containing emotional or relatively arousing sounds played in the background while participants watched the slides with the neutral version of the story. The control group for

these participants was a group that listened to neutral background sounds while also watching the neutral version of the story and slides. In order to differentiate between short-term and long-term memory responses to arousal, participants' memory was tested either immediately after the slide show, or after a delay of 7 days. All participants responded to both a free recall task and a recognition test in an attempt to assess memory more comprehensively.

It is expected that arousal will increase memorial accuracy for central features, only when it is part of the content, especially after a delay. Conversely, arousal as part of the context will be as detrimental to memory as neutral background sounds. It is also expected that arousal as part of the content material will be detrimental to memory of peripheral information, especially for short-retention intervals. Although these predictions will probably be observed with the recognition test, they will be more prominent with the free recall task. In an attempt to uncover correlates of individuals' memory capacity, cognitive and personality variables were collected from participants. It is expected that individuals' capacity for absorption, imaginative thinking, one's beliefs about one's own memory capacity as well as self-monitoring will have some valuable predictive power for their accurate memory recall.

METHOD

Participants

A total of 104 student volunteers (18 males, 86 females) were recruited through psychology classes at Concordia University. Appendix A presents the script used to sign up participants. Volunteers were aged between 18-74 years with a mean of 24 (±7). Fourteen participants had to be dropped from the study for various reasons including failing to return for the second part of the experiment, etc.

Materials

Slide show:

The stimulus materials were those used by Cahill and McGaugh (1995), who generously provided copies of the slides used in their study. Participants in all groups viewed the same 11 slides, depicting the story of a mother and son who go to visit father at work at the hospital. A one-sentence audiotaped narrative (see Appendix B) accompanied each slide. Two versions of the narratives were used to differentially induce emotional arousal in-groups. The two stories differed in the middle phase of the slides (i.e., four slides: slides 5-8). In the arousal-inducing version, the boy gets badly hurt in an automobile accident and the hospital staff struggle to save his life. In the neutral version, the boy watches as the staff practices a disaster drill. The same pictures which in the neutral version are described as routine aspects of a disaster drill are described in the arousal version as attempts to save the boy's life.

The audiotapes:

The *Arousing Environmental Sounds* are a collection of recorded special sound effects including crying, screaming, and coughing sounds, as well as other

environmental sounds from machines and animals. For detailed information about specific sounds used in this experiment, refer to Appendix C. This audiotape was piloted on a group of 12 volunteers and was found to reliably induce moderate levels of emotionality (average rating of 6 out of 10) as self-reported by participants on a Likert-type scale (Lang, 1980; see Appendix D). The International Affective Digitized Sounds (Lang & Bradley, 1990) that has been shown to reliably increase the level of emotionality in people inspired this collection of sounds, which were recorded from the sound effects library.

The *Neutral non-specific background sounds* was recorded from sounds of a university entrance hallway on a typical busy day, with the bustling sounds of people talking, walking, etc. Unlike white noise, these sounds are not monotonous and are more difficult to block out by subjects. This audiotape was effectively used as a control measure for the group that heard the arousing sounds.

The four personality questionnaires:

The *Autobiographical Memory Questionnaire* (Czank & Conway, 1994) (see Appendix E) is a series of 21 statements about the self to which participants rate their level of agreement on a 5-point scale from 1 to 5, from "strongly disagree" to "strongly agree". The scale is designed to measure people's beliefs in their memorial ability. It has been used in several other studies (Moghrabi, 1998; Czank & Conway, 1994) but as yet, no standard norms have been developed.

The *Tellegen's Absorption Scale* (Tellegen, 1981) (see Appendix F) is a measure of spontaneous involvement in imaginable and aesthetic stimuli, as well as openness or tendency to alter perception of oneself in daily experiences. It contains 34 true-false items about appreciation and involvement in everyday

events (i.e., nature, music and art), in fantasy or in unusual experiences. Scores range from 0 to 34.The TAS has been reported to have an internal consistency alpha coefficient of 0.89 (Isaacs, 1982).

The *Individual Differences Questionnaire* (Paivio, 1971) (see Appendix G) is a 21-item self-report scale measuring individual differences in imagery and visualization abilities. Participants respond to each question on a 5-point Likert scale rating how characteristic a given statement is of themselves ranging from "extremely uncharacteristic" with a rating of -2 to "extremely characteristic" with a rating of +2. Responses are then converted to a 5-point scale from 1 to 5, with 1 representing -2 and 5 representing +2. Scores are then summed and range from 1 to 105. Statements address visual abilities, richness of imagination, and dream imagery.

The *Snyder's Self-Monitoring Scale* (Snyder, 1986) (see Appendix H) consists of 25 true-false self-descriptive statements that describe concern with situational appropriateness of self-presentation. Scores range from 0 to 25. Several studies on normative properties have revealed the mean of the SSM scale to be 12.5 with a standard deviation of 4. The SSM scale has been reported to have an internal Kuder-Richardson 20 reliability coefficient of .66 and a test-retest reliability of .86 (Snyder, 1974; 1986). The self-monitoring construct relates to individual differences in information people use to guide self-presentation. Individuals high in self-monitoring or those who score more than one standard deviation above the mean (>16), are highly concerned with the situational appropriateness of their behavior and attempt to regulate and control their social behavior on the basis of the situational cues they receive. Low self-monitors or those who score below the mean (<7), are less attentive to social information about the situational appropriateness of their behavior. Instead, their own attitudes and emotions guide their behavior.

The Digit Symbol Substitution test:

The Digit Symbol (DS) test (see Appendix I) is one of the subscales of the Weschler Adult Intelligence Scale (Wechsler, 1981). It measures speed and accuracy of visual-spatial memory and attentional skills. Participants' performance on the DS provided an index of their potential for memory and concentrative abilities. The DS test requires participants to copy symbols paired with numbers. At the top of the test, a key consisting of boxes displaying numbers 1 to 9 inclusively in the upper part and a symbol in the lower part. Each number is paired with a different symbol. The test stimuli are boxes containing a number in the upper part and an empty box in the lower part. The task involves filling as many empty boxes as possible with the appropriate paired symbol in 90 seconds. There are seven sample stimuli followed by 93 test stimuli. Scores can range from 0 to 93. Scores were then converted to scaled scores from 1 to 19 according to the Weschler Adult Intelligence Scale's normative reference sample. The mean for the DS is 10 (±3).

Recognition test:

The recognition test consisted of a multiple-choice test of 76 questions. Overall, there were 5 to 9 questions for each of the 11 slides. In answering the questions, participants had three alternatives to chose from. Responses were then summed for slides 1 to 4 as phase 1, for slides 5 to 8 as phase 2 and slides 9 to 11 as phase 3. Phase 1 and phase 3 of the narratives were identical for all groups. Phase 2 represents the phase where arousal was differentially induced in the different experimental groups.

Design and procedure

Upon arrival, volunteers were told that we were interested in the relationship between personality characteristics and on how people made sense

of a story. They were also told that the effects of auditory sounds on their comprehension of the story were being studied. All participants were told to simply view the slide show that would last approximately 5 minutes. They were told to watch the slides as they would any movie and to pay attention to each slide. We noted that it was important for them to pay attention and understand the slide show and its story. They were notified that after the slide presentation, they would be asked to complete some personality questionnaires as well as perform an attentional task. After all questions were answered, all volunteers signed the consent form (see Appendix J).

Participants were randomly assigned to one of four experimental groups. Subjects were tested in groups of 4-7 people. All groups viewed the same 11 slides depicting a story of a mother and son who visit father at the hospital. Each slide was shown for 15 seconds. The slides were projected on a large screen 70 cm x 90 cm, about 2 to 3 meters from participants. The groups listened to different versions of the one-sentence audiotaped narrative accompanying each slide. In the content-arousing condition, participants listened to the arousing version of the story of the slides where the boy gets badly hurt in a car accident. In the other three groups, participants listened to the neutral version of the story where the boy watches the hospital staff practice a disaster drill.

In the context-arousing condition or the group who was exposed to the arousing sounds, volunteers listened to and viewed the neutral slide show while the Arousing Environmental Sounds audiotape of arousing sounds played in the background. In the context-distracting condition, subjects also listened to and viewed the neutral version of the story while an audiotape of background sounds played in the room. The Arousing Environmental Sounds and the neutral non-specific background sounds audiotapes were played at a 50 dB level while the one-sentence narrative accompanying the slide show played at 70 dB to allow

participants to comfortably listen to the slide show story.

Immediately following the slide show, all participants were asked to rate the slide show story on a 10-point rating scale with respect to emotionality, comprehension and interest. In addition to these three rating scales, participants in the context-arousing and context-distracting conditions were asked to rate the background sounds on similar 10-point scales with respect to distraction, disturbance, pleasantness and calmness of the sounds (see Appendix K). All participants then completed the four personality questionnaires. Each questionnaire was introduced briefly by its name and they were instructed to answer the questions with the first thing that came to mind without much pondering. They were then instructed to complete the timed Digit Symbol test, a subtest of the Wechsler Adult Intelligence Scale-Revised (Wechsler, 1981).

Following the DS test, participants were then tested individually by examiners. They were each given two memory tests: a free recall task and a recognition test regarding the slides they had seen. Half of participants were given the memory tests immediately following the DS test and the remaining participants completed them after a one-week delay. Participants' responses to the free recall task was audiotaped for later analysis. The recognition test (see Appendix L) was borrowed from Cahill and McGaugh (1995). At the end of the experiment, all participants were thoroughly debriefed and thanked for their participation. They were asked not to discuss the experiment with their classmates since they may volunteer for the study as well. All volunteers had access to the results of the study upon request. Appendix M presents the script used by examiners for the present experiment.

Data coding

Verbatim transcriptions of participants' responses to the free recall

memory test constituted a source of qualitative data for the present study. The encoding process of the participants' transcriptions involved several successive steps. Protocols were first segmented into single units of information. Generally these units are verb and adverb phrases (for action details, e.g., "holding hands") or noun and adjective phrases (for descriptive details, e.g., "green dress") (Yuille & Cutschall, 1986). Each statement was then coded according the coding scheme proposed by Burke, Heuer and Reisberg (1992). Statements were categorized into four types of information: central information (i.e., plot relevant or plot defining) was subdivided into gist (i.e., the who, what, where of the plot) and basic-level visual information (i.e., elements which described what the slide showed such as the mother walking as opposed to sitting), peripheral information was categorized into either details about central characters or details about background elements.

These coding categories are based on earlier categorizations by Heuer and Reisberg (1990) and Christianson and Loftus (1991). Participants' errors were categorized as either fictitious substitutions (i.e., substituting an element for another in the plot) or fictitious additive statements (i.e., elements that participants simply added to their renditions of the story). Each erroneous statement was further subdivided according the four main types of information categories mentioned above (i.e., central gist information, central basic visual information, details of central characters and details of background elements). Finally, some participants made attributional statements that could not be categorized as either veridical or erroneous. These statements were categorized as attributions, ascribing motivations to characters, over-interpretations or judgments of the story's elements (see Appendix N for a detailed list of the coding categories used for protocol analysis).

Furthermore, for the total number of slides remembered by each

participant, respondents were credited with remembering a slide if they described some feature in their verbal transcriptions that was only visible in that slide and not in any other slide. Using these successive steps, the examiner coded all the verbal transcriptions in a quasi-blind experiment (on occasion, subjects' renditions made it clear what version of the narrative they heard). Another independent examiner re-coded 20 percent of the transcriptions to establish an inter-rater reliability coefficient of 83 percent.

Data Analysis

For each coding category, the number of statements made by each respondent was summed and these frequency counts constituted the main source of data for the free recall task. For purposes of analysis, participants' erroneous statements were combined into two main types of errors: substitutions and additive statements. Also, all respondents' attributive statements were combined into one main category. The final coding categories used for analysis are listed in Appendix N. It is important to note that because the frequency counts could be fractions of elements, the variables were considered to be continuous in nature and inferential parametric statistics were thus conducted.

RESULTS

The data contained in this study includes several dependent measures and result from three different experimental manipulations. Appendix O lists all the independent and dependent variables as well as the subject factors used in this study. Reference to this appendix will help make sense of the types of analyses that were conducted on the data and will facilitate understanding of this section on results.

Tests of assumptions for parametric analyses and normality

First, the assumption of independent observations was satisfied in this study since volunteers were randomly assigned to the different experimental conditions and were individually tested for all of the dependent measures. All distributions of continuous variables were submitted to univariate normality tests, as this is an assumption of statistical tests used to analyze the data. Since the data in this study contained two grouping variables (arousal vs. neutral story/context and immediate vs. delayed memory retention interval), it was necessary to conduct analyses for normality separately for some dependent variables that would be subject to changes as a result of these manipulations. For example, ratings of emotionality of the story were expected to vary considerably across the experimental groups because affect was the concept being manipulated hypothetically. By the same token, measures of memory recall would be expected to differ considerably depending on the retention interval condition.

Tests of normality were conducted on the ratings of emotionality, interest and comprehension of story separately for each of the four groups of arousal manipulations (arousal vs. neutral story and context). Because theoretically, these measures should not be affected by retention intervals, the tests were

done separately only for the four experimental groups. The Shapiro-Wilk statistic on the measures of emotionality was not found to be significant for each of the four experimental groups. The null hypothesis of normality on the ratings of story interest was not rejected for any of the groups, except for the group exposed to the arousing sounds where the distribution was positively skewed (i.e., subjects rated the story low on measures of interest). The null hypothesis of normality on the ratings of story comprehension was rejected for each of the four groups because of the consistently high ratings by subjects overall.

Tests of normality were also conducted on the ratings of the background sounds separately for the two groups exposed to them. The tests were not done separately by retention interval condition since the ratings were assumed not to be affected by different retention intervals. The extent to which sounds were upsetting to subjects was found to be normally distributed for the group exposed to the arousing sounds but positively skewed for the group exposed to the neutral background sounds because of this group's low ratings on this scale. The null hypothesis of normality on the distractibility of the sounds was rejected for the groups because the distributions were both heavy-tailed, no doubt due to the small sample size (n=26). Similarly, the tests of normality on the ratings of calmness and pleasantness of the sounds were significant for both groups.

Tests of normality were also conducted on the four personality measures. The Shapiro-Wilk statistic was conducted on the overall distribution of these measures without separation by any of the grouping variables since, theoretically, these personality measures should not be influenced by experimental manipulations. The null hypothesis of normality on the Snyder's Self-Monitoring Scale and the Tellegen Absorption Scale were not rejected. The null hypotheses of normality on the Individual Differences Questionnaire and the Autobiographical Memory Questionnaire were rejected. In both cases, the

distribution of scores were negatively skewed (i.e., relatively high scores by participants).

Tests of normality were also done on the measures of memory recall and recognition. These tests were done separately by retention interval condition because subjects' recall and recognition would be expected to vary considerably across different conditions. They were not done separately for the groups because the null hypothesis would predict that memory recall for all the stories, whether emotional or neutral would be similar. The Shapiro-Wilk statistic on all recognition measures across the two different conditions was found not to be significant, thus the null hypothesis of normality was not rejected.

The null hypothesis of normality on the total number of main story elements and the number of central gist elements recalled were also rejected for both conditions. The null hypothesis of normality for the number of basic visual elements recalled by subjects was rejected the delayed retention interval. For the immediate retention condition, the null hypothesis of normality was not rejected because the data was negatively skewed (i.e., many visual elements recalled). The null hypotheses of normality on the recall for central and background details were not rejected for both retention conditions, again because of the scarcity of detail subjects recalled overall.

The test of normality on the total number of erroneous substitutions made by subjects in the free recall of the story was also done separately only for the two retention conditions. The null hypothesis of normality was rejected because of the paucity of substitutions made by subjects overall. The null hypothesis of normality on the number of fictitious additions made by subjects in their recall of the story was also rejected for both retention conditions because of the paucity of additions made overall. The null hypothesis of normality on the total number of attributions made by participants in their recall of the story was rejected for both

retention conditions because of the scarcity of attributions made overall by subjects.

All distributions of the dependent measures were screened for the presence of outliers. Cases with standardized scores in excess of $z = \pm 3.00$ were considered as outliers. By this definition, no outliers were identified for any of the measures.

Homogeneity of variances among all the dependent variables were verified by the F max tests.

In conclusion, the tests of normality revealed very few dependent variables that are not normally distributed (i.e., comprehension and recall measures). Given the robustness of the ANOVA test, the equal cell sizes and homogeneous within-treatment variances, no data transformations were deemed necessary.

Ratings of arousal, interest level and comprehension of the stories

All participants rated the extent of emotionality, interest level and comprehension of the stories on Likert-type scales numbered from 1 to 10. A 4 (groups) x 2 (retention intervals) ANOVA on the ratings of emotionality of the stories was found to be significant [$F(7, 96)=7.18$, $p<.0001$]. It revealed a main effect for group adherence [$F(3)=16.51$, $p<.0001$]. Duncan's multiple range test showed that the arousal group differed significantly from the other three groups in their mean ratings of emotionality. The mean ($\pm$ SD) rating for the arousal group was 7.04 ($\pm$1.54), nearly twice that of the other three groups (between 3.31 $\pm$1.98 and 4.0 $\pm$2.74 for the other groups). Thus, the stories effectively produced increased levels of emotional arousal only in the arousal group. No main effect of retention intervals was revealed.

A 4 (groups) x 2 (retention intervals) ANOVA on the ratings of interest level of the story was significant [$F(7, 96)=5.55$, $p<.0001$]. A main effect of group adherence was revealed [$F(3)=12.20$, $p<.0001$]. The arousal group (5.88 ±1.84) scored almost two times higher on the ratings of interest level of the story than the other three groups (average scores between 2.85 ±2.11 and 3.19 ±2.37). Despite the experimenter's efforts to differentiate between subjects' ratings of emotionality and interest levels in the story, these two measures do appear to be confounded constructs that may be difficult to disentangle. They are indeed significantly correlated [$r=.53$, $p<.0001$]. Figure 1 depicts the ratings of emotionality and interest level of the story for all four experimental groups. As compared to the other groups, the arousal group rates visibly higher on both measures. The figure also clearly illustrates how closely these two measures correlate with one another for all groups. No main effect of retention intervals was revealed.

A 4 (groups) x 2 (retention intervals) ANOVA on the ratings of story comprehension was significant [$F(7, 96)=2.66$, $p<.05$]. It revealed a main effect of group adherence [$F(3)=15.34$, $p<.01$]. Post hoc tests revealed that participants' ratings of comprehension were very similar for the arousal and the neutral groups and the group exposed to the neutral background sounds. However, the group exposed to the arousing sounds (7.69 ±2.22) scored significantly lower than the other three groups (average scores between 8.9 ±1.98 and 9.5 ±0.71) on ratings of story comprehension. It may be that arousing environmental sounds interfere with the understanding of a simple slide show. Despite the statistical significance of this observation, however, the average rating of comprehension for the group exposed to the arousing sounds was still relatively high (7.69 ±2.22 on a Likert scale from 1 to 10) and only about one point lower than the other groups. No other main effect was found.

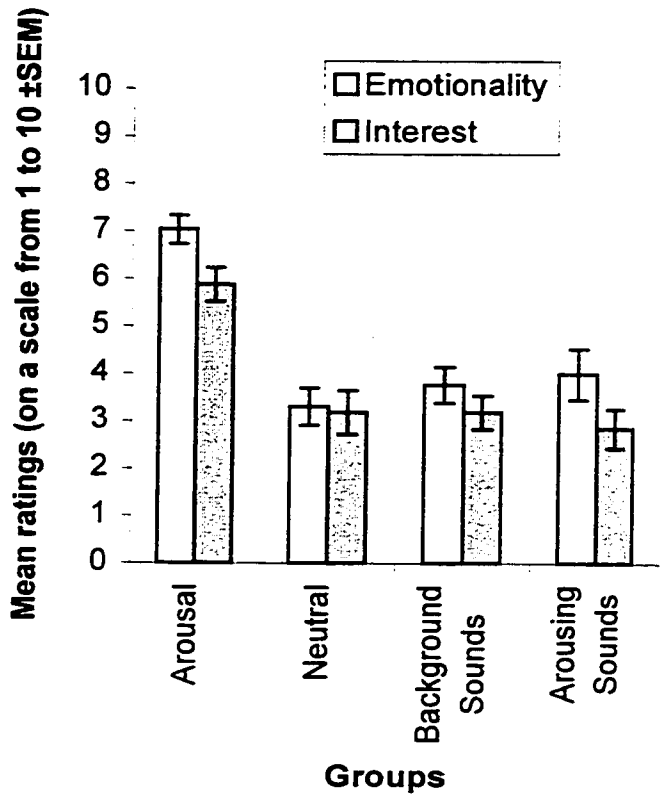

Figure 1. Ratings of emotionality and interest level of the story for each group

Ratings of the background sounds

Groups exposed to background sounds rated the extent to which the sounds were upsetting, distracting, pleasant and calming on Likert-type scales numbered from 1 to 10. A 2 (groups) x 2 (retention intervals) ANOVA on ratings of the extent to which the sounds were upsetting was found to be significant [$F(3, 48)=5.97$, $p<.005$]. It revealed a main effect for group adherence [$F(1)=17.89$, $p<.0001$]. Duncan's multiple range test revealed that the group exposed to the arousing sounds (5.04 ±3.07) found the sounds significantly more upsetting than the group exposed to the neutral background sounds (1.69 ±2.49). Therefore, the different background sounds successfully induced higher levels of emotionality in the group exposed to the arousing sounds. No main effect for retention interval was revealed.

A 2 (groups) x 2 (retention intervals) on the distractibility level of the sounds was found to be significant [$F(3, 48)=4.54$, $p<.01$]. It indicated a main effect for groups [$F(1)=13.57$, $p<.001$]. The group exposed to the arousing sounds (6.73 ±2.65) found the sounds significantly more distracting than the group exposed to the neutral background sounds (3.77 ±3.02). It is possible that the ratings of distraction and emotionality are constructs that are confounded in this study. They are indeed highly correlated [$r=.62$, $p<.0001$]. Figure 2 presents participants' ratings of distractibility of the sounds and the extent to which the sounds were upsetting. The group exposed to the arousing sounds rated the sounds as more distractible and more upsetting than the other group.

Subjects in the two background sound groups did not differ in their ratings of the sounds' pleasantness and calmness. It is noteworthy to mention that these

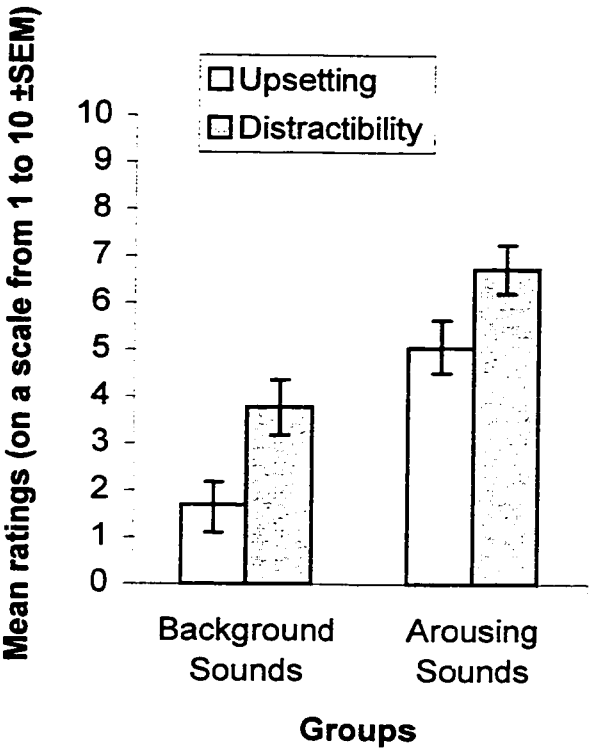

Figure 2. Ratings of background sounds on degree of distractibility and extent to which they were upsetting for each group exposed to sounds

two constructs appeared to measure very similar constructs as they were found to correlate significantly with one another [r=0.50, p<.001].

Subject factors (Digit Substitution test, gender and age)

The groups did not differ on their performance of the Digit Substitution Test, thus providing evidence that the groups were very similar with regard to visual-spatial memory capacity.

The groups were very similar with regard to age and gender distribution. However, it is important to note that overall, there were significantly more women participating in this study than men (female to male ratio was 43:9). Fortunately, very few gender differences were observed in the constructs measured in the study. A t-test on the ratings of emotionality revealed that women (4.79 ±2.55) scored higher than the men (3.28 ±2.14) in the study [t(102)=2.35, p<.05]. Figure 3 illustrates the ratings of emotionality of the story for males and females in each experimental group. Although the arousal group's ratings of emotionality of the story are visibly higher than that of the other groups, the women's ratings in each group are consistently higher than the men's ratings. No other gender differences were revealed for the summative dependent variables.

Of interest is the observation that men (88% ±49%) recalled the fifth slide (i.e., depicting a car on the sidewalk) more often than women (65% ±56%) did [t(102)=2.01, p<.05]. This observation should not affect the overall memory performance on the entire slide show that consisted of 11 slides. The only other gender difference was in the number of over-interpretations made about the story [unequal variances: t(58)=2.18, p<05]. Women made an average of .77 (±1.48) over-interpretations about the story whereas men made an average of .28 (±0.67) such over-interpretations. As mentioned earlier, for purposes of later analysis, the frequency count of over-interpretations was added to three other

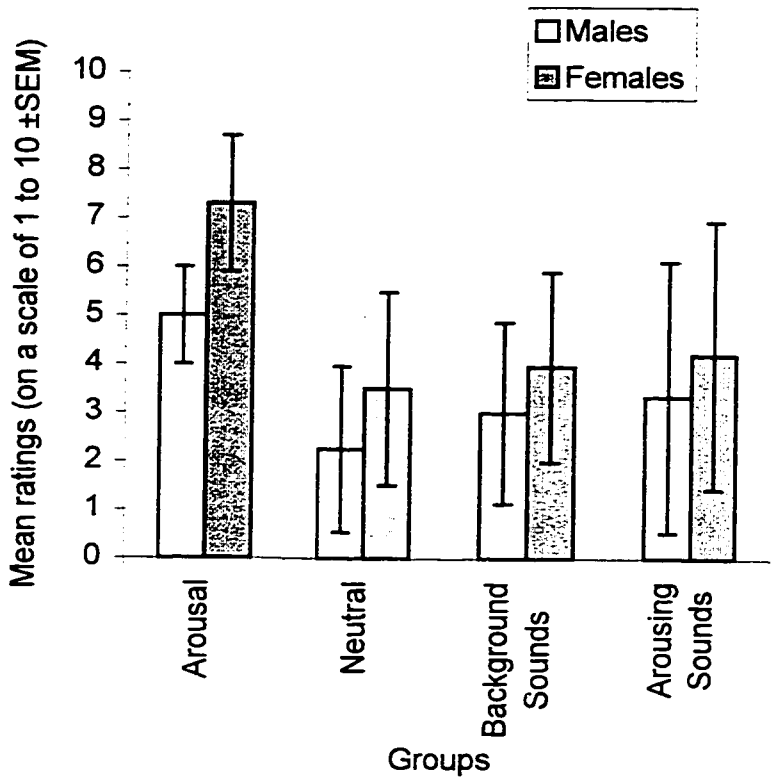

Figure 3. Ratings of emotionality of story for males and females in each group

types of attributions (i.e., ascribing motivational thoughts to the characters, making judgements about the story or its characters and other attributions) made by participants, therefore, this gender difference should not compromise the overall results of the study.

Personality Measures (Tellegen, IDQ, SSMS, Autobiographical Scale)

The groups did not differ in their self-scored capacity for absorption (as measured by the Tellegen Absorption Scale), self-monitoring tendency (as measured by the Snyder's Self-Monitoring Scale) and belief in their own memorial capacity (as measured by the Autobiographical Memory Scale). However, a 4 (groups) x 2 (retention intervals) ANOVA on the Individual Differences Questionnaire (IDQ) was found to be significant [$F(7, 96)$, $p<.05$]. A main effect for group adherence was revealed [$F(3)=4.99$, $p<.005$]. Post hoc tests revealed that the group exposed to the neutral background sounds had significantly lower measures of self-scored capacity for imagery and imaginative thinking (77.5 ±18.19) than the other groups (average scores between 87.54 ±8.93 and 88.96 ±9.92). Measures of IDQ were thus co-varied in all further analyses dealing with personality predictors of memory accuracy.

Multiple-choice recognition test results

The results of the multiple-choice recognition test are reported separately for the three phases of the slide show. Phases 1 and 3 of the story are identical for all four groups of participants. Phase 2 of the story represents the slides where arousal was induced for the arousal group. For the other three groups, phase 2 of the story was identical and presented the neutral version of the story. Phase 1 consists of the first 4 slides; phase 2 consists of the next 4 slides; phase 3 consists of the last 3 slides.

Figures 4 to 7 depict the mean percentage of correct responses (±SEM) on the recognition test for each of the four experimental groups and the two retention interval conditions. Figure 4 illustrates the test results for phase 1 of the story. Participants' performances are clearly superior in the immediate retention condition as compared to the delayed condition. Their performance also declines steadily as a function of the group adherence: it is highest for the arousal group (74.55 ±3.69), followed by the neutral (71.10 ±2.28), the group exposed to the neutral background sounds (67.66 ±3.03) and finally, it is lowest for the group exposed to the arousing background sounds (57.83 ±3.03). As a matter of fact, the performance of the group exposed to the arousing sounds is of the same magnitude in the immediate retention condition (57.83 ±3.03) as it is in the delayed retention condition (49.07 ±2.31) illustrating the debilitating effects of the sounds on memory.

Figure 5 presents the results of the recognition test for phase 2 of the story. In the immediate retention condition, participants' performances in the arousal group (76.64 ±2.36) paralleled the performances of the participants in the neutral group (79.93 ±2.32). By the same token, the performances of the two groups exposed to the background sounds were comparable (73.07 ±2.14 and 71.43 ±4.39 respectively for the neutral background and the arousing background sounds). The arousal and the neutral groups, however, clearly outperformed the two groups exposed to the background sounds. Most striking in the figure is the observation that the performance of the arousal group was just as high in the delayed retention condition (65.64 ±3.96) as it was in the immediate retention condition (76.64 ±2.36). That was certainly not the pattern for the other groups whose performances were considerably lower in the delayed retention condition as compared to the immediate retention condition (54.39 vs. 79.93 for the neutral group, 51.36 vs. 73.07 for the neutral background sounds,

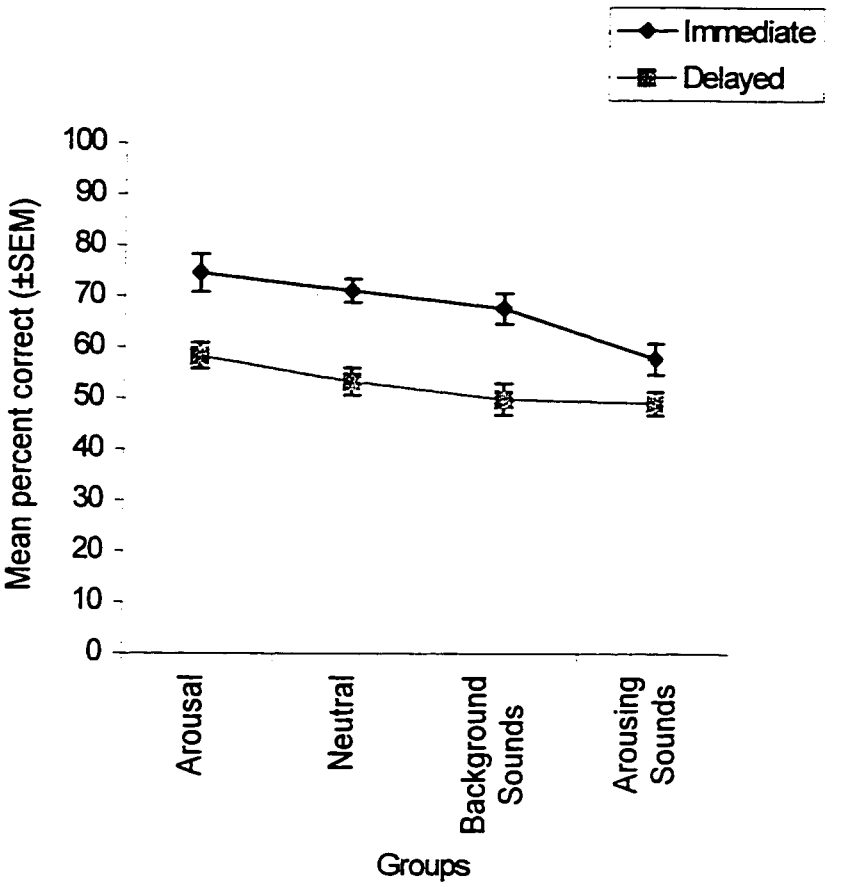

Figure 4. Mean recognition test results for phase 1 of the story for each group and retention interval

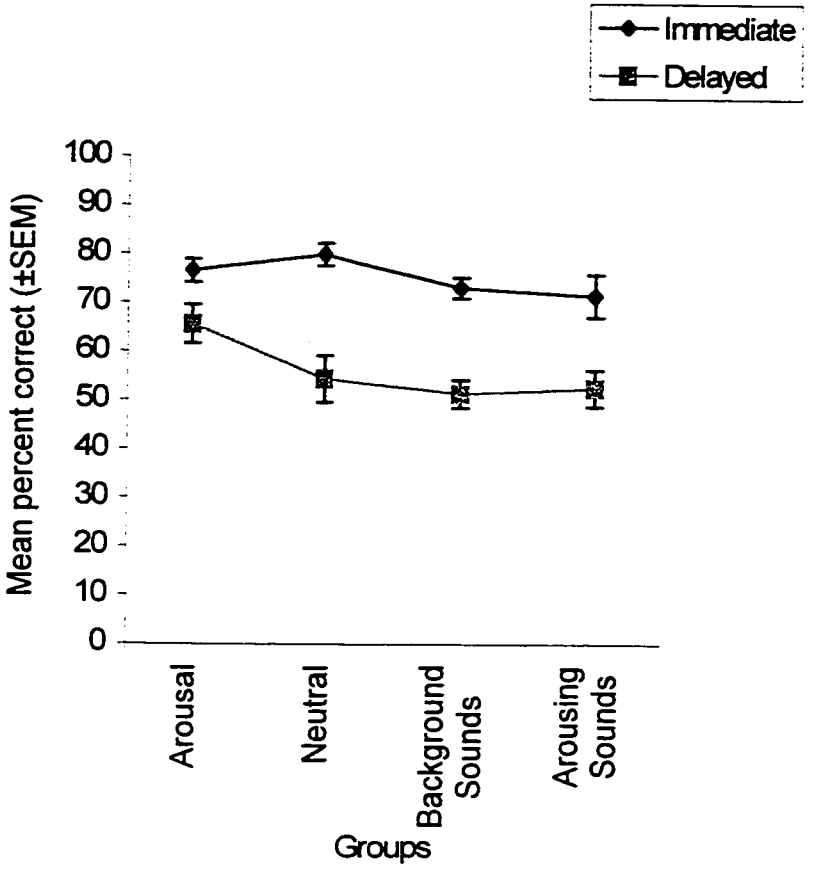

Figure 5. Mean recognition test results for phase 2 of the story for each group and retention interval

52.46 vs. 71.43 for the arousing sounds). In the delayed condition, the arousal group's (65.64 ±3.96) performance is strikingly superior to that of the other groups whose performances parallel one another closely (54.39 ±4.79; 51.36 ±2.82; 52.46 ±3.71 for the neutral, neutral background sounds and arousing sounds respectively).

Figure 6 shows the results of the recognition test for phase 3 of the story. In the immediate retention condition, the arousal (76.11 ±3.16) and the neutral groups (80.58 ±1.84) visibly outperform the two groups exposed to the background sounds (72.47 ±3.84 and 69.63 ±3.42 respectively for the neutral background sounds and the arousing sounds). In the delayed retention condition, only the group exposed to the arousing sounds (52.1 ±3.53) visibly performed lower than the other three groups (61.53 ±4.84; 59.89 ±2.89 and 61.53 ±2.79 respectively for the arousal, the neutral and the two background sounds groups).

Figure 7 illustrates each group's results on the overall recognition test. For the immediate retention condition, performance declines linearly across the four experimental groups from the arousal (75.5 ±2.72) to the neutral (76.72 ±1.79) to the group exposed to the neutral background sounds (70.86 ±2.14) to the group exposed to the arousing sounds (65.79 ±3.2). In the delayed retention condition, only the performance of the arousal group (61.84 ±2.8) is slightly higher than that of the other groups whose performances closely parallel one another (55.37 ±2.42; 53.34 ±2.03; 51.12 ±2.36).

A 4 (groups) x 2 (retention intervals) ANOVA on the test results of phase 1 of the slide show was found to be significant [$F(7, 96)=11.34$, $p<.0001$]. Two main effects for groups [$F(3)=7.1$, $p<.001$] and retention intervals [$F(1)=54.73$, $p<.0001$] were revealed. In the recognition of phase 1 of the slide show, post-hoc tests showed that the average percentage of correct responses (mean percent

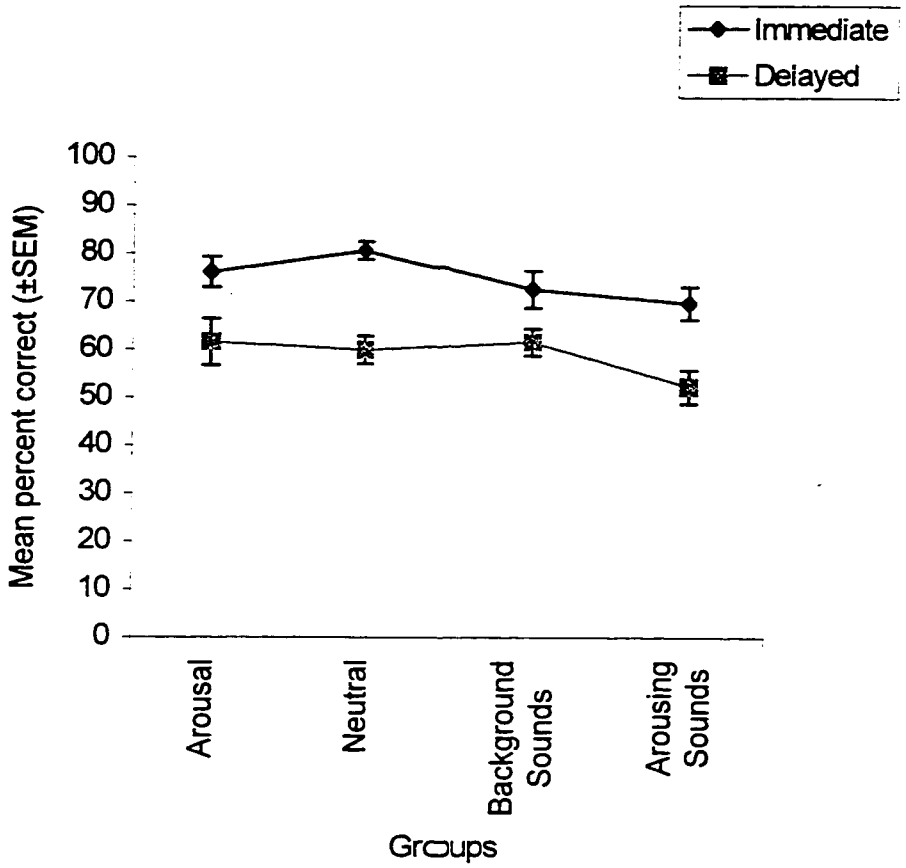

Figure 6. Mean recognition test results for phase 3 of story for each group and retention interval

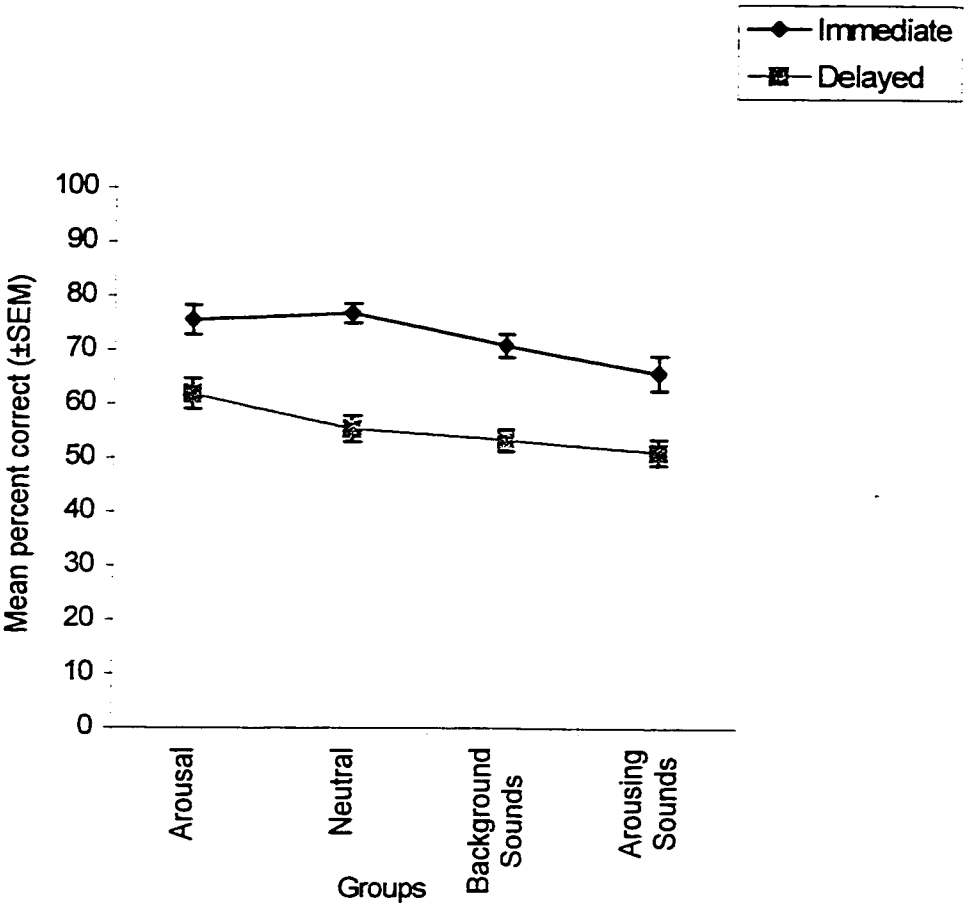

Figure 7. Mean of total recognition test results for each group and retention interval

correct ±standard deviation) by the arousal group (66.17 ±13.72) did not differ from that of the neutral group (62.21 ±12.62). The arousal group did, however, outperform the group exposed to the neutral background sounds (58.76 ±14.07) and the group exposed to the arousing sounds (53.45 ±10.55) in the recognition of phase 1 of the slide show. Not surprisingly, the group with the immediate retention interval (67.66 ±12.34) recognized more information about the first phase of the slide show than the group whose memory recognition was tested with one week delay (52.66 ±10).

Another 4 x 2 ANOVA conducted on the recognition test results from phase 2 of the slide show was found to be significant [$F(7, 96)=11.0$, $p<.0001$]. Main effects for group adherence [$F(3)=3.24$, $p<.05$] and retention intervals [$F(1)=62.47$, $p<.0001$] were indicated. Again, the performance of the arousal group (71.14 ±12.86) did not differ from that of the neutral group (67.18 ±18.64). However, the arousal group did outperform the two groups exposed to the background sounds (62.21 ±14.14) and the arousing sounds (61.96 ±17.32). The immediate retention group (75.29 ±10.89) also recognized more information than the delayed retention group (55.96 ±14.75).

The participants' performance on phase 3 of the slide show paralleled their performance on the other two phases of the story. The 4 x 2 ANOVA on the results of the recognition test for phase 3 was found to be significant [$F(7, 96)=7.81$, $p<.0001$]. Main effects for group adherence [$F(3)=2.91$, $p<.05$] and retention intervals [$F(1)=43.74$, $p<.0001$] were revealed. The arousal (68.84 ±16.32) and the neutral group (70.26 ±13.58) performed similarly to one another. These two groups both outperformed the group exposed to the arousing sounds (60.95 ±15.21). However, only the neutral group was found to have recognized more information than the group exposed to the neutral background sounds

(67 ±13.1). Again, the immediate retention group (74.68 ±11.79) recognized more information than the delayed retention group (58.79 ±13.26).

The 4 (group) x 2 (retention interval) ANOVA on the results of the overall recognition test was found to be significant [$F(7, 96)=16.39$, $p<.0001$]. Main effects for group adherence [$F(3)=6.56$, $p<.001$] and retention intervals [$F(1)=92.13$, $p<.0001$] were indicated. The post-hoc tests showed that the arousal (68.67 ±12.01) and the neutral (66.04 ±13.24) groups recognized significantly more information about the slide show than the group exposed to the arousing sounds (58.45 ±12.45). Also, the arousal group recognized significantly more information than the group exposed to the neutral background sounds (62.09 ±11.58). Not surprisingly, the group with an immediate retention interval (72.22 ±9.85) recognized more information than the group with a one-week delayed retention interval (55.42 ±9.38).

Number of Slides Recalled by Each Group

Participants' free recall narrative was analyzed to calculate the number of slides recalled by each group. Subjects were credited with remembering a slide if they described some feature that was visible only in that slide and not in any other slide or mentioned in the narrative of the story. The number of slides recalled by subjects is again reported separately for each of the three phases of the story: the beginning phase (phase 1) identical for all the groups, the middle phase (phase 2) induced arousal for one group but is neutral for the others and the final phase (phase 3) identical for all groups.

Figures 8 and 9 illustrate the percentage of slides recalled by participants for each phase of the story. Figure 8 presents the results for the immediate retention condition whereas figure 9 presents the information for the delayed retention condition. For the immediate retention condition, the only notable

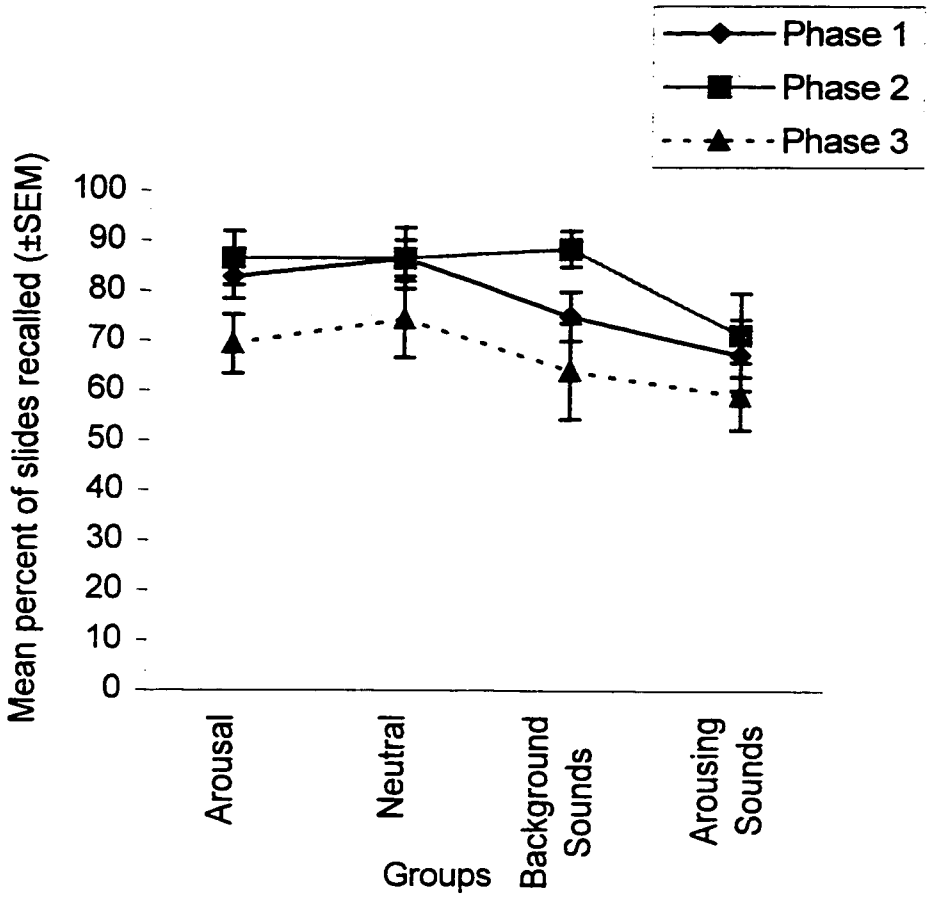

Figure 8. Phase by phase percentage of slides recalled for each group in the immediate retention condition

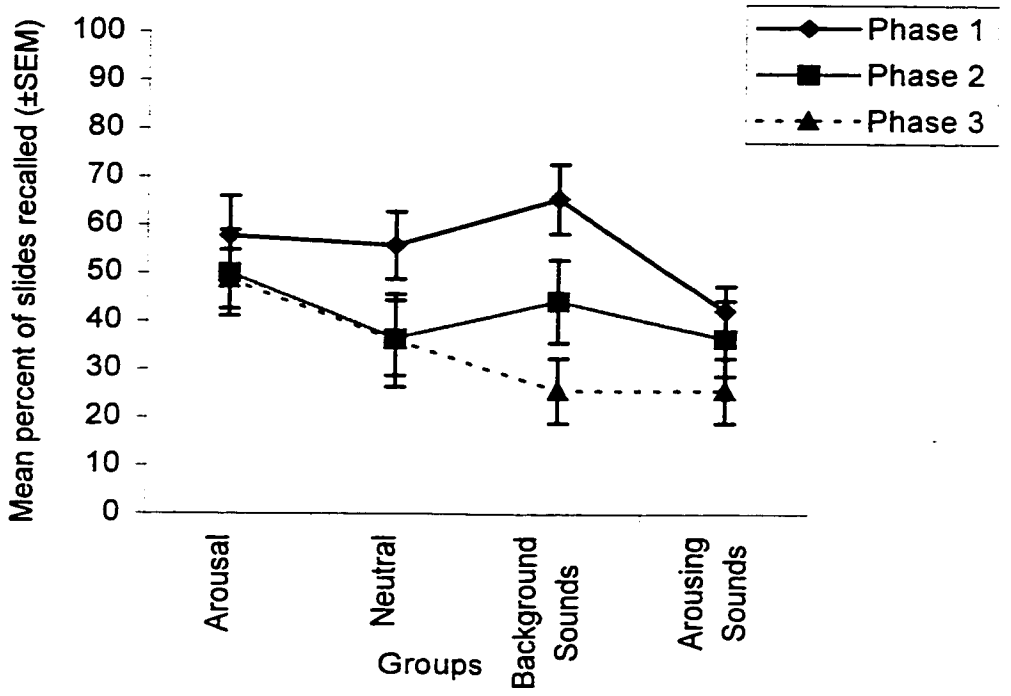

Figure 9. Phase by phase percentage of slides recalled for each group in the delayed retention condition

observation is that in comparison to the other phases, phase 3 was consistently least well remembered by all groups. Phase 2 slides also appear to be remembered more often than phase 1 slides. In the delayed retention condition, the chronological order of the slides appeared to determine the recall performance of the slides (phase 1 was remembered better than phase 2, which was remembered better than phase 3). The arousal group appears to recall slides from all three phases of the story consistently well, recalling about half or more of the slides. The arousal group visibly outperforms the other groups in its recall of slides pertaining to phase 2 of the story, recalling half of those slides whereas the other groups all recalled less than half of them.

Figure 10 shows the total percentage of slides that were recalled by participants in each group. In the immediate recall condition, the arousal and the neutral groups do not differentiate themselves from each other but both do outperform the groups exposed to the background sounds. Overall, in the delayed condition, the arousal group recalled more than half of the slides whereas the other groups recalled consistently fewer than half of the slides.

A 4 (groups) x 2 (retention intervals) ANOVA on the number of slides recalled in phase 1 was found to be significant [$F(7, 96)=5.71$, $p<.0001$]. Main effects for group adherence [$F(3)=3.26$, $p<.05$] and retention intervals [$F(1)=26.94$, $p<.0001$] were indicated. Post hoc tests showed that the group exposed to the arousing sounds recalled an average of 2.19 slides (±1.02) as compared to the other groups who recalled an average of 2.81 (±1.06 and ±0.9) to 2.85 slides (±1.01). Also, on average the immediate retention group recalled about 3.12 slides (±0.78) whereas the delayed group recalled about 2.21 slides (±1.04).

A 4 x 2 ANOVA conducted on the number of slides recalled in phase 2 was found to be significant [$F(7, 96)=10.06$, $p<.0001$]. No main effect of groups

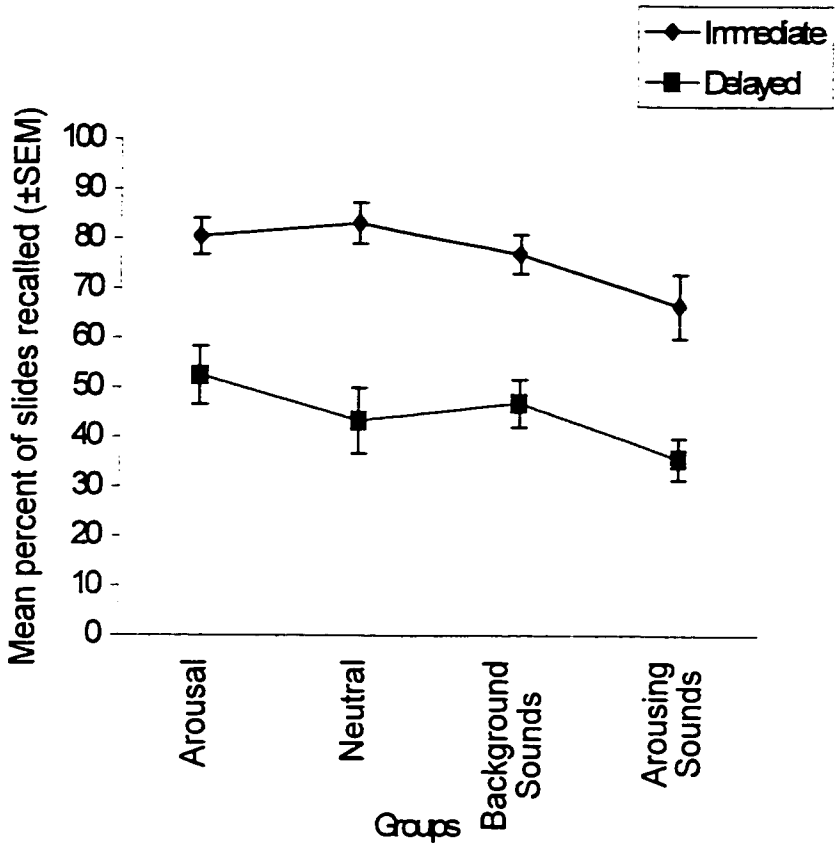

Figure 10. Percentage of all slides recalled for each group and retention condition

was found. Only a main effect for retention interval was revealed [F(1)=64.31, p<.0001]. The immediate retention group recalled an average of 3.33 slides (±0.9) whereas the delayed group recalled about 1.67 slides (±1.04). A 4 x 2 ANOVA conducted on the number of slides subjects recalled in phase 3 of the story was found to be significant [F(7, 96)=6.67, p<.0001]. A trend toward a main effect for group adherence [F(3)=2.27, p<.09] as well as a main effect for retention interval [F(1)=37.97, p<.0001] were demonstrated. In phase 3, the arousal group recalled an average of about 1.77 (±0.71) slides whereas the group exposed to the arousing sounds recalled only 1.27 slide (±0.87). Also, the immediate retention group recalled an average of 2 slides (±0.82) whereas the delayed group recalled an average of 1.02 slide (±0.83).

A 4 x 2 ANOVA on the total number of slides recalled by participants was found to be significant [F(7, 96)=13.14, p<.0001]. Main effects for groups [F(3)=3.46, p<.05] and retention intervals [F(1)=80.01, p<.0001] were indicated. Post hoc tests indicated that the group exposed to the arousing sounds recalled an average of 5.62 slides (±2.73) as compared to the other groups who recalled an average of about 7 slides (7.31 ±2.48; 6.96 ±3.09; 6.81 ±2.4 respectively for the arousal, neutral and neutral background sounds groups). Also, the immediate retention group (8.44 ±1.93) recalled more slides than did the delayed retention group (4.90 ±2.21).

Free Recall Test Results: Qualitative Data

Total number of main story elements recalled:

A content analysis of participants' verbal transcripts enabled the experimenters to examine important qualitative features of subjects' recall of the story and to determine whether any differences existed across the experimental groups. Figure 11 presents the total number of correct story elements that were

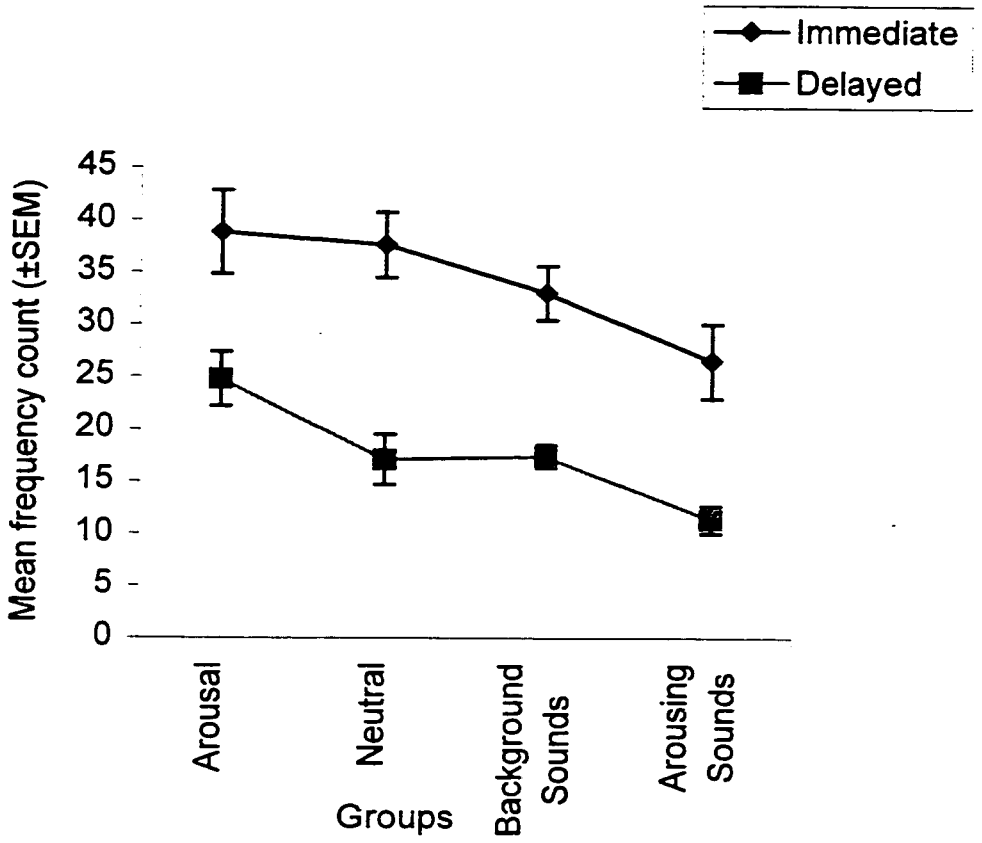

Figure 11. Total number of story elements recalled for each group and retention interval condition

recalled by participants in each group. Story elements is broadly defined here, including both central elements about the story such as the who, what and where of the story as well as finer details such as details about the background environment or the characters in the story. The figure presents the mean frequency count of story elements (±SEM) for each group and retention condition. In the immediate condition, the performances of the arousal group and the neutral group and the group exposed to the neutral background sounds closely parallel one another (38.83 ±4; 37.6 ±3.13; 33.02 ±2.58, respectively). Only the group exposed to the arousing sounds (26.48 ±3.55) appeared to recall the least number of story elements. Visibly, subjects' performance in the immediate retention condition is characterized by more variability than in the delayed retention condition.

In the delayed retention condition, clearly the arousal group (24.79 ±2.59) outperforms all the other groups. The performance of the two control groups, namely the neutral group (17.1 ±2.41) and the group exposed to the neutral background sounds (17.4 ±1.07), closely parallel one another. The group exposed to the arousing sounds (11.33 ±1.28) notably recalls the least number of story elements.

A 4 (groups) x 2 (retention intervals) ANOVA on the total number of story elements participants correctly recalled during the free recall task was found to be significant [$F(7, 96)=13.57$, $p<.0001$]. Main effects for group adherence [$F(3)=7.62$, $p<.0001$] and retention intervals [$F(1)=70.50$, $p<.0001$] were revealed. Post hoc tests indicated that the arousal group (31.81 ±13.90) recalled significantly more story elements than the two groups exposed to the sounds (25.21 ±10.60 and 18.90 ±12.20 for the group exposed to the neutral sounds and the arousing sounds, respectively). Also the group exposed to the arousing sounds recalled significantly less than all the groups. Also, the immediate

retention group (33.98 ±12.73) recalled nearly twice as many story elements than the delayed group (17.65 ±8.38).

Main story elements were further subdivided into number of central gist information (the who, what, where of the story), central basic visual information (elements representing visual actions or facts, e.g., "mother was walking"), details about central characters and details about the background. Results of these categories are discussed below.

Central gist elements recalled

Figure 12 demonstrates the number of central gist elements (±SEM) of the story recalled by participants in each group. In the immediate retention condition, the arousal (11.85 ±0.61) and the neutral groups (12.17 ±0.56) performed similarly to one another. In the delayed retention condition, the arousal group (9.62 ±0.79) recalled nearly as many central gist elements as they had in the immediate retention condition, and outperformed the other groups. The performances of the two control groups, namely the neutral group (6.96 ±0.8) and the group exposed to the neutral background sounds (8 ±0.72), paralleled one another in this condition. The group exposed to the arousing sounds (4.69 ±0.55) visibly recalled the least number of central gist elements.

A 4 (groups) x 2 (retention intervals) ANOVA on the main elements recalled by participants in their free recall was found to be significant [$F(7, 96)=12.74$, $p<.0001$]. It revealed main effects for groups [$F(3)=13.17$, $p<.0001$] and retention intervals [$F(1)=42.32$, $p<.0001$]. There was also a strong trend toward an interaction between group adherence and retention intervals [$F(3)=2.45$, $p=.06$]. The groups differed significantly in the number of main story elements recalled. In decreasing order of performance, the arousal group (10.73 ±2.74) recalled more story elements than the neutral group (9.57 ±3.71) which in

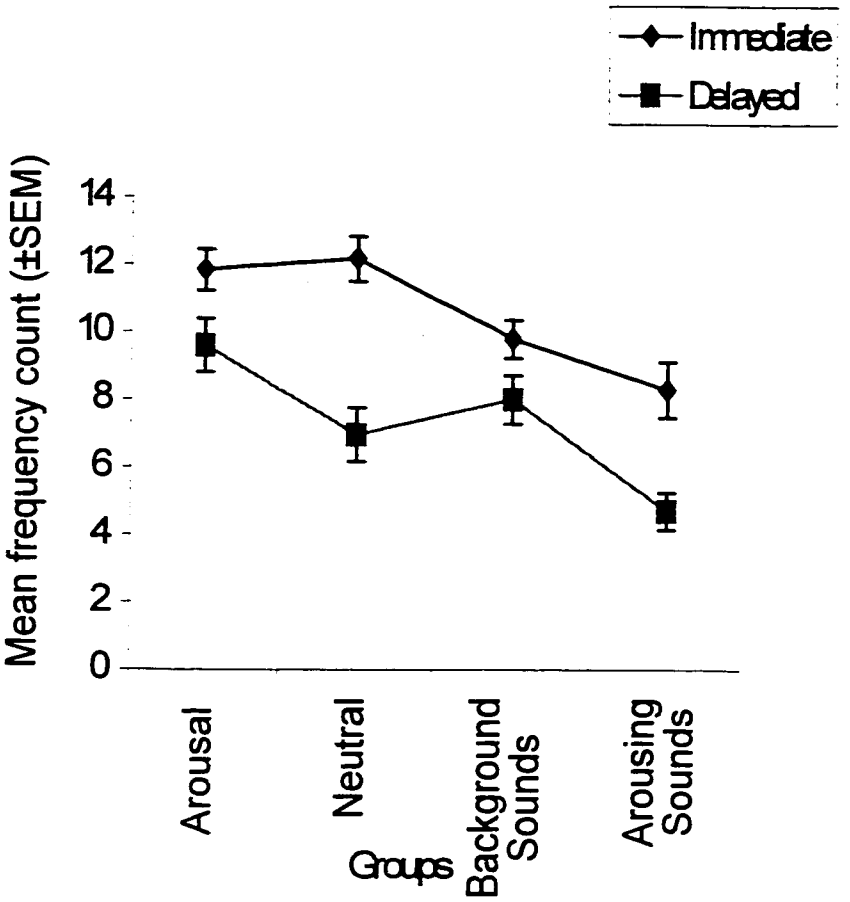

Figure 12. Mean frequency of story elements recalled by each group and retention interval

turn recalled more story elements than the group exposed to neutral background sounds (8.89 ±2.45). As well, the group exposed to the arousing sounds recalled the least number of story elements (6.49 ±3.08) as compared to the other groups. The immediate retention interval group (10.52 ±2.84) recalled significantly more story elements than the delayed retention interval group (7.32 ±3.10).

As shown in Figure 12, there was also a strong trend towards an interaction between group adherence and retention interval. For the immediate retention interval, the arousal (11.85 ±2.19) and the neutral (12.17 ±2.39) groups performed similarly to one another but visibly better than the two groups exposed to the sounds (9.79 ±2.03, 8.29 ±2.97, for the neutral background sounds and the arousing sounds, respectively). For the delayed retention interval, the arousal group (9.62 ±2.86) outperformed the neutral group (6.96 ±2.88) by recalling an average of 3 more main story elements. Similarly, the group exposed to the neutral background sounds (8.0 ±2.59) recalled an average of 3 more story elements than the group exposed to the arousing sounds (4.69 ±1.98). The neutral group performed very similarly to the group exposed to the neutral background sounds. In this experiment, the former group represented the control group for the arousal group and the latter represented the control group for the group exposed to the arousing sounds.

Central basic visual information recalled:

Figure 13 presents the number of basic visual elements recalled by participants in each experimental group. In comparison to the other groups, the group exposed to the arousing sounds recalled remarkably fewer basic visual elements in both the immediate retention condition as well as in the delayed retention condition.

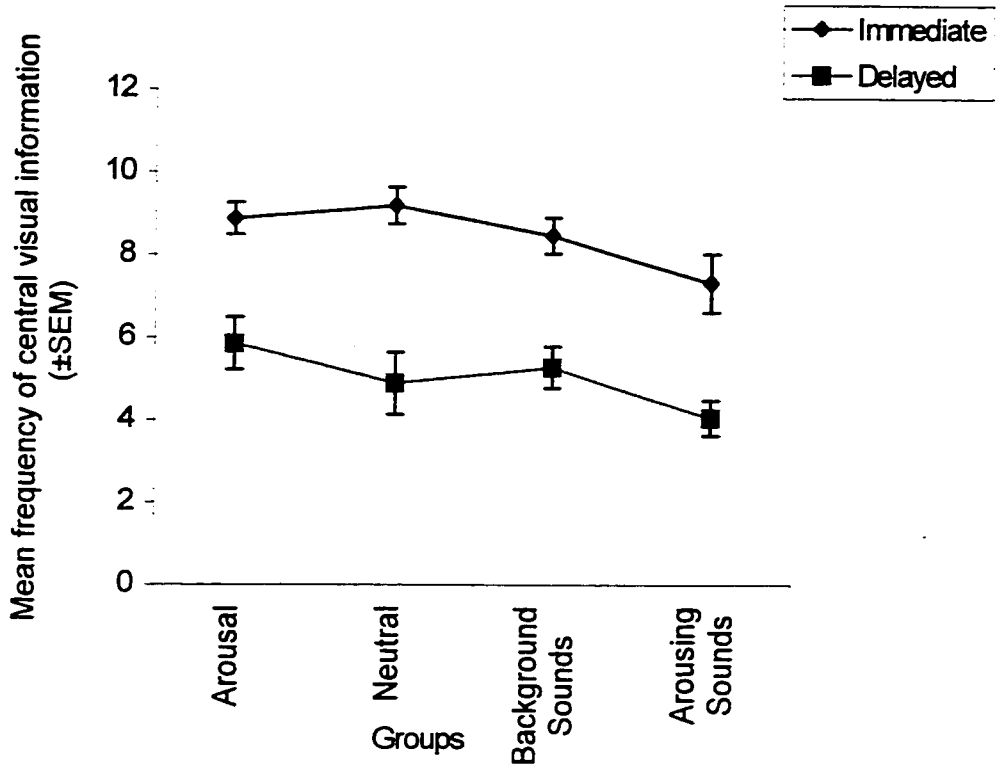

Figure 13. Mean frequency of central visual information recalled for each group and retention interval

A 4 x 2 ANOVA on the number of basic visual elements recalled by participants during their free recall was found to be significant [F(7, 96)=12.84, p<.0001]. It indicated main effects for groups [F(3)=3.55, p<.05] and retention intervals [F(1)=77.62, p<.0001]. The arousal group (7.37 ±2.42), the neutral group (7.04 ±3.10) and the group exposed to neutral background sounds (6.87 ±2.33) recalled comparable numbers of visual elements. However, the group exposed to arousing sounds (5.67 ±2.66) recalled fewer visual elements than the other groups. Not surprisingly, the immediate retention group (8.46 ±1.92) recalled more visual elements than the delayed retention group (5.01 ±2.19).

Background details recalled:

Figure 14 portrays the frequency of details recalled about the background environment by participants in the experimental groups. The immediate retention condition is characterized by wide variability in subjects' performances. Otherwise, the groups did not differ from each other in their recall of background details. In the delayed retention condition, the arousal group (3.62 ±0.99) evidently outperformed the other groups (1.02 ±0.27; 0.79 ±0.34 and 0.96 ±0.32 respectively for the neutral, the group exposed to neutral background sounds and to arousing sounds).

A 4 x 2 ANOVA on the number of details recalled about the background environment by participants during their free recall of the story was found to be significant [F(7, 96)=6.96, p<.0001]. It demonstrated main effects for group adherence [F(3)=5.79, p<.001] and retention intervals [F(1)=29.89, p<.0001]. Of all the groups, the arousal group (5.81 ±5.58) recalled the most background details, almost twice as many as the other groups (3.27 ±3.84, 2.54 ±2.46, 2.20 ±3.01, for the neutral group, the groups exposed to the neutral background sounds and the arousing sounds, respectively). As well, the immediate retention

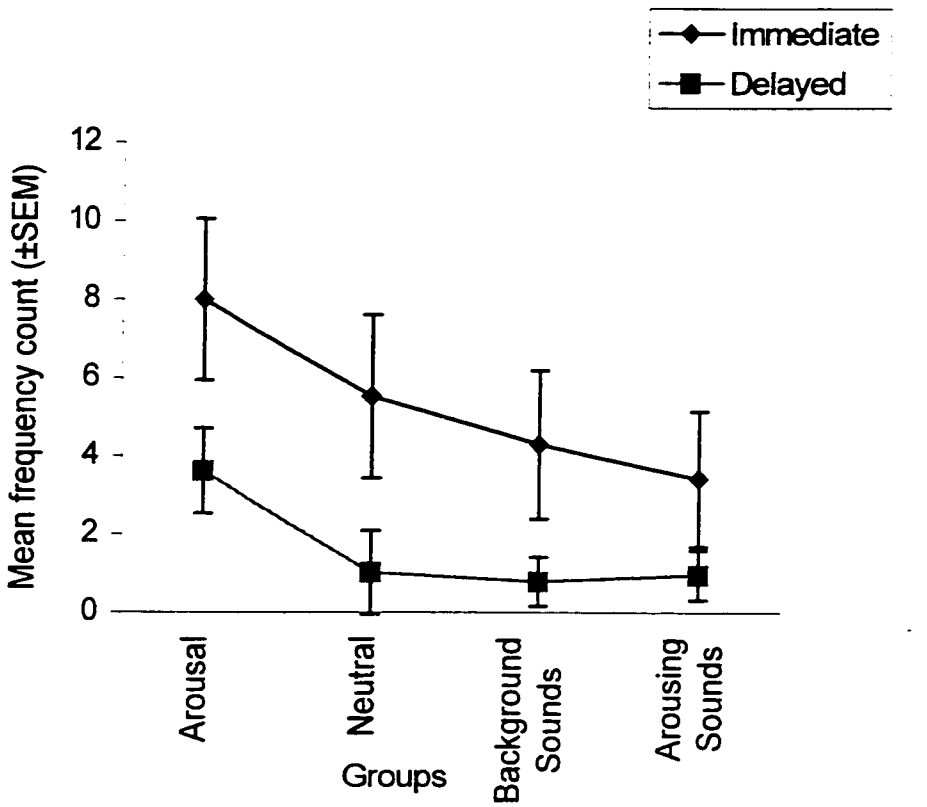

Figure 14. Mean frequency of background details recalled for each grop and retention interval

group (5.31 ±4.65) recalled more background details than the delayed retention group (1.60 ±2.31).

Central details recalled:

Figure 15 depicts the frequency of central details subjects recalled about the story. In the immediate retention condition, the large amount of variability in subjects' recall performance failed to show any differentiation between the groups. In the delayed retention condition, however, the arousal group (5.71 ±1.09) distinctly outperformed the other groups (4.23 ±1.07; 3.35 ±0.63 and 1.63 ±0.64 respectively for the neutral, the group exposed to the neutral background sounds and the arousing sounds) in the recall of details about central characters.

The 4 x 2 ANOVA on the number of central details participants recalled was found to be significant [$F(7, 96)=5.39$, $p<.0001$]. A main effect for retention intervals [$F(1)=30.97$, $p<.0001$] and a trend toward a main effect for groups [$F(3)=1.95$, $p=.13$] were revealed. The arousal group (7.90 ±6.23) recalled more central details than the group exposed to the arousing sounds (4.55 ±5.49). The immediate retention group (9.69 ±6.94) recalled more central details than the delayed retention group (3.73 ±3.44).

Erroneous substitutions:

Figure 16 illustrates the frequency of substitutions participants made in their recall of the story. The immediate and the delayed retention conditions could not be differentiated from each other. However, the arousal group (3.23 ±0.54 and 3.19 ±0.68 for the immediate and the delayed conditions respectively) made more substitutions in their free recall of the story than the neutral group (1.83 ±0.3 and 1.69 ±0.38 for the immediate and the delayed conditions respectively).

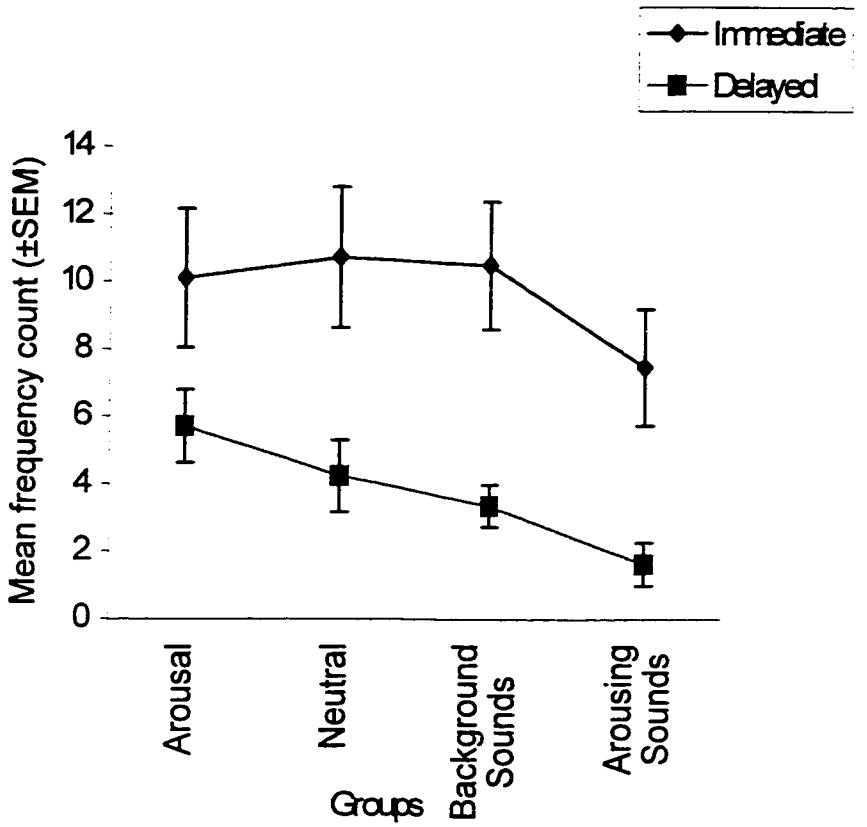

Figure 15. Mean frequency of central details recalled by each group and retention interval

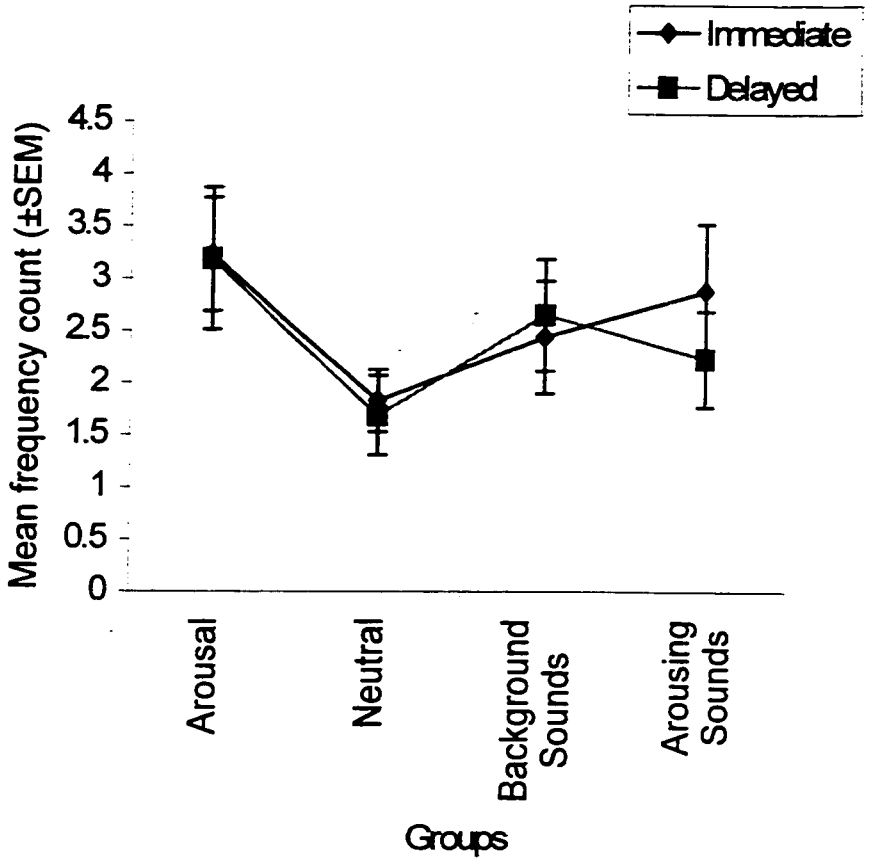

Figure 16. Mean frequency of erroneous substitutions made during recall

A 4 x 2 ANOVA conducted on the total number of story elements subjects fictitiously substituted for another element in the free recall of the story was found not to be significant. However, the group main effect approached significance [F(3)=2.58, p<.06]. Post hoc tests revealed that the neutral group (1.76 ±1.21) made fewer substitutions than the arousal group (3.21 ±2.17). There was no difference between the two retention groups in the number of substitutions made.

Fictitious additions:

Figure 17 shows the frequency of fictitious additions participants mentioned in their free recall of the story. Interestingly, the delayed retention condition recounted more additions than the immediate retention condition. In both conditions, the arousal group (2.08 ±0.61 and 3.54 ±1.17 for the immediate and the delayed conditions respectively) made more fictitious additions than the neutral group (0.77 ±0.28 and 1.54 ±0.51 respectively for the immediate and the delayed conditions). As a matter of fact, the neutral group appeared to recall fewer additions than the two groups exposed to the sounds (1.62 ±0.61; 2.85 ±0.42; 2.31 ±0.52; 3.04 ±0.97 for the neutral background sounds and the arousing sounds in the immediate and the delayed conditions, respectively).

A 4 x 2 ANOVA conducted on the total number of elements subjects fictitiously added in their free recall of the story was found to approach significance [F(7, 96)=1.70, p=.12]. There was a main effect for retention interval [F(1)=4.53, p<.05] and a trend toward a main effect for group adherence [F(3)=2.32, p=.08]. In comparison to all the groups (2.81 ±3.39, 2.23 ±1.97, 2.67 ±2.79, for the arousal, the neutral background sounds and the arousing sounds groups, respectively), the neutral group (1.15 ±1.52) was the only one that significantly added the least number of fictitious story elements in their free recall of the story [F(3)=2.32, p<.10]. Also, the immediate retention group (1.69 ±1.94)

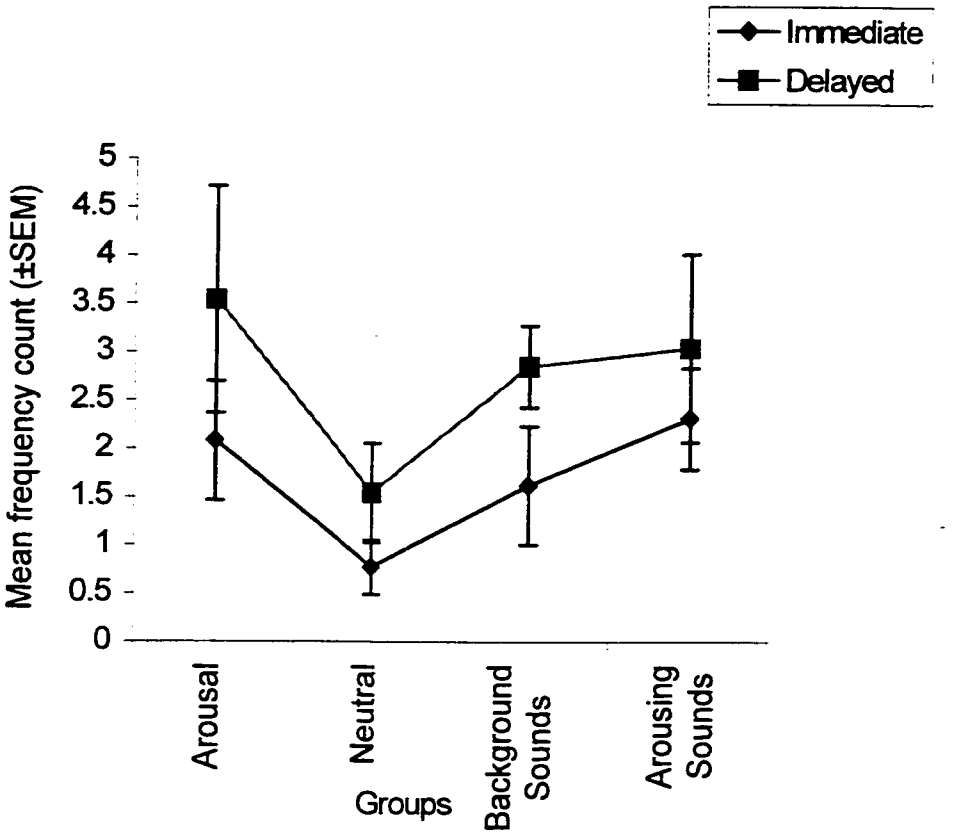

Figure 17. Mean frequency of fictitious additions made during recall

added fewer fictitious story elements in their free recall than the delayed retention group (2.74 ±3.01).

Attributions made about the story or its characters:

Figure 18 portrays the frequency of attributions participants made in their free recall of the story. In all the groups except the arousal group, the frequency of attributions made in the immediate retention condition (3.38 ±1.03; 4.69 ±1.36 and 5.23 ±1.04 for the neutral, neutral background sounds and arousing sounds, respectively) was visibly highly than the number made in the delayed condition (1.92 ±0.46; 2.46 ±0.47 and 2.46 ±0.56 for the neutral, neutral background sounds and the arousing sounds groups, respectively). For the arousal group, however, participants made just as many attributions in the immediate retention condition (5.92 ±1.97) as they did in the delayed retention condition (5.54 ±1.22).

An ANOVA conducted on the total number of attributions made by subjects during their free recall of the story approached significance [$F(7, 96)=1.97$, $p<.07$]. The main effect for group adherence approached significance [$F(3)=2.63$, $p=.05$]. The arousal group (5.73 ±5.79) made significantly more attributions than the neutral group (2.65 ±2.92). The ANOVA also revealed a significant main effect for retention intervals [$F(1)=4.63$, $p<.05$]. Interestingly, the immediate retention group (4.81 ±5.0) made more attributions about the story than the delayed retention group (3.10 ±2.99).

Figures 19 and 20 present the proportion of story elements and intrusions made during recall for each experimental group in the different retention conditions. In the immediate condition, only the neutral group had the lowest proportion of intrusions with as much as 86% of their recall elements consisting of accurate story elements. Generally speaking, however, all the groups were fairly accurate in their recall and had minimal proportions of intrusions (i.e., about

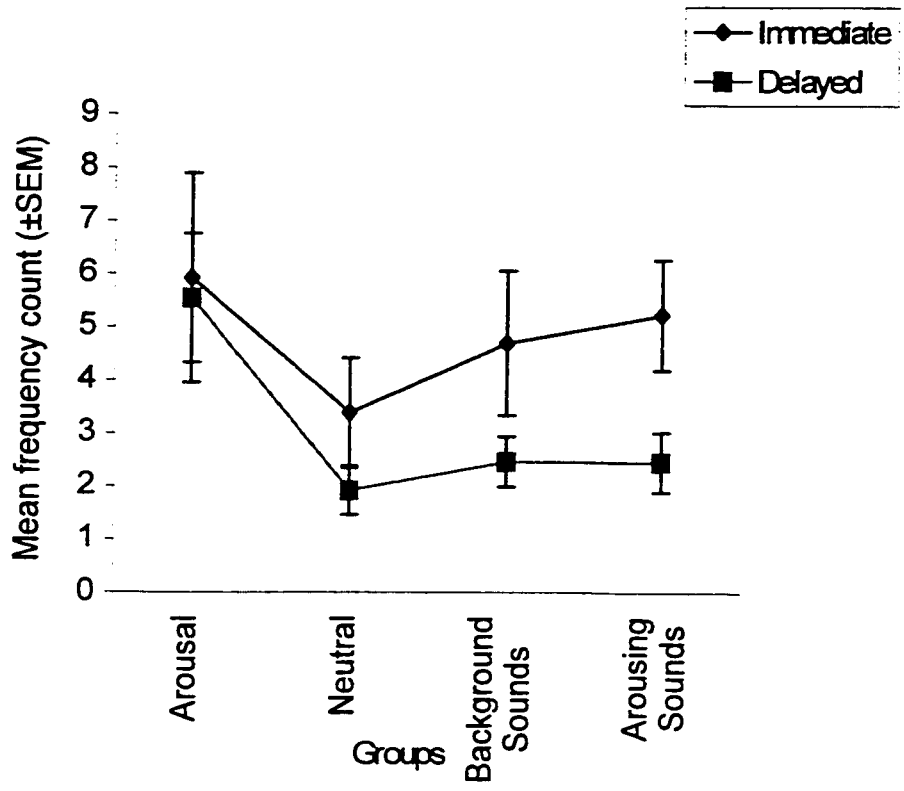

Figure 18. Frequency of attributions made during recall

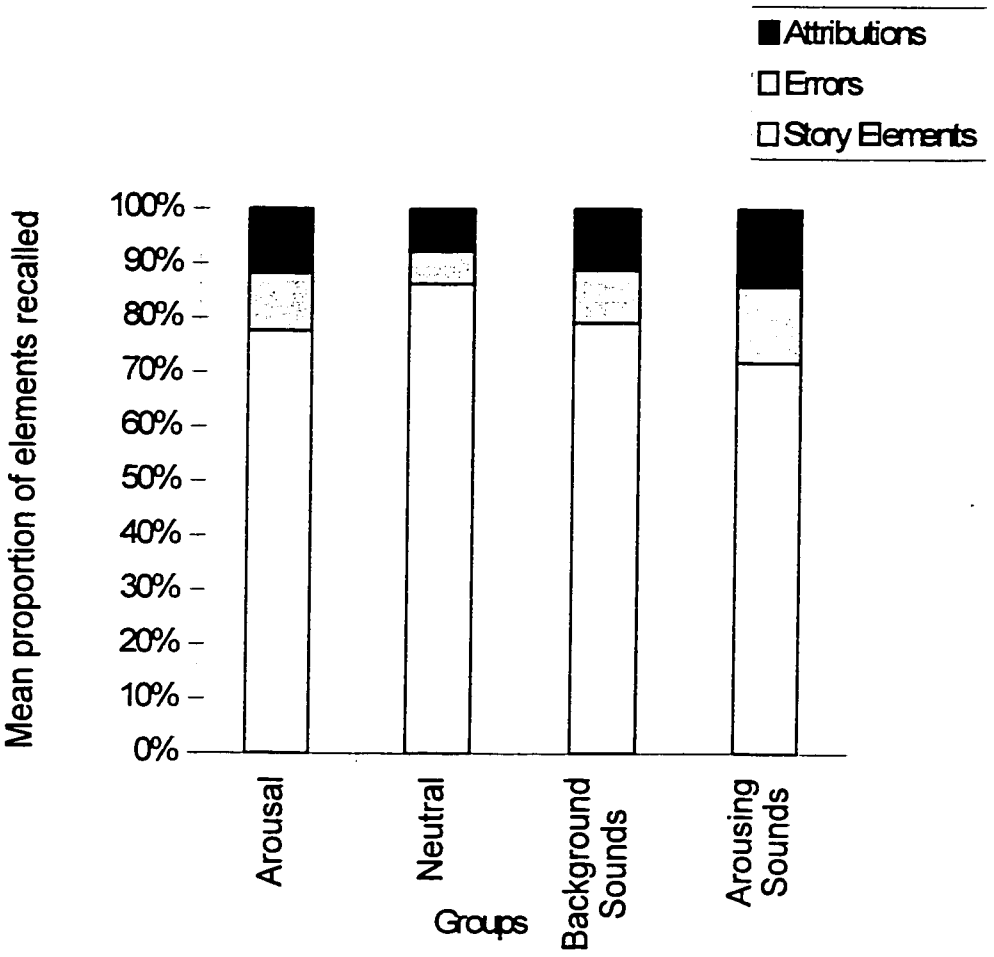

Figure 19. Proportion of story elements and intrusions made during immediate recall

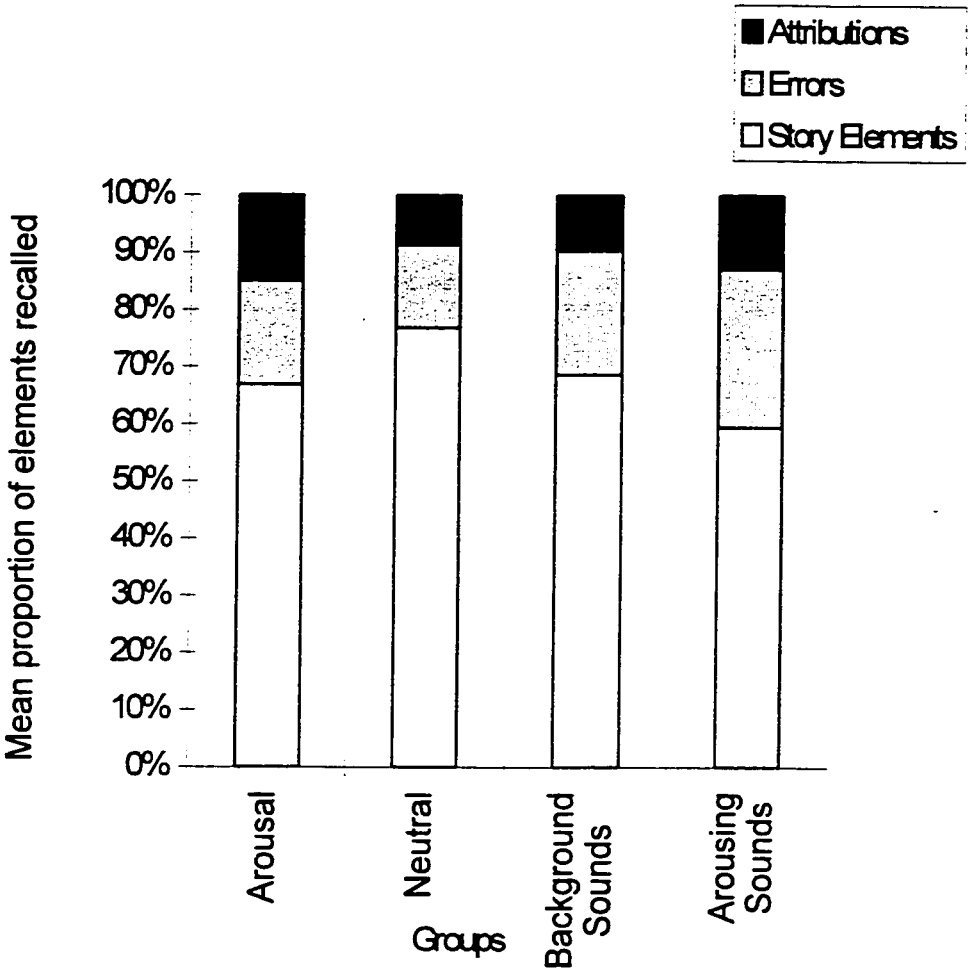

Figure 20. Proportion of story elements and intrusions made during delayed recall

25%). Also noteworthy to mention is the observation that in the immediate condition, intrusions across all the groups consisted of equal proportions of errors and attributions. In the delayed condition, of all the groups, the neutral group again had the lowest proportion of intrusions with less than 25% of their recall consisting of errors or attributions. In the other groups, however, over 33% of their recall consisted of intrusions. The group exposed to the arousing sounds reaches the highest proportion of intrusions with only 59% of their recall consisting of factual story elements. It does appear that with time (i.e., delayed condition), the proportion of errors made during recall doubles across all the groups whereas the proportion of attributions made remain quite stable. With regards to group comparisons, however, the group viewing the arousing story had the highest proportion of attributions.

Personality Measures as Predictors of Memory

Multiple regressions were conducted of the dependent variables on the four personality measures to determine the predictive value of subjects' scores on the four personality measures. Only one significant prediction was revealed from the analyses. The Individual Differences Questionnaire predicted a significant 13% of the variance in the number of memory intrusions (i.e., errors and attributions) participants made during free recall [$F(4, 99)=2.68$, $p<.05$].

Significant inter-correlations among variables

Appendix P presents a correlation matrix with all the major variables in this study and their inter-correlations. The table does not include the measures of the background sounds' pleasantness and calmness because these two measures were not found to correlate with any of the measures in a meaningful way. Also, the matrix does not include certain demographic measures such as age because of the limited age range in the present study. However, the few

statistically significant results with these measures are mentioned. Correlation coefficients that were found to be statistically significant (i.e., $p<.05$) have been grayed out in the table for easy reference. It is noteworthy to caution against over-interpretations of these significant results given the number of correlations conducted and their modest coefficients.

Among noteworthy observations are the many significant correlations between the IDQ, the Autobiographical Memory Questionnaire (AMQ) and the Tellegen Absorption Scale (TAS) [TAS &IDQ $r=0.38$, $p<.0001$; IDQ & AMQ $r=0.26$, $p<.01$; TAS & AMQ $r=0.23$, $p<.02$]. As a matter of fact, it would appear that the TAS, the IDQ and the AMQ all measure very similar if not the same constructs. The SSMS did not significantly correlate with the other measures. However, the older the participant, the lower they scored on the SSMS [$r=-0.26$, $p<.01$]. Interestingly, measures of IDQ were significantly associated with the number of attributions [$r=0.22$, $p<.05$] and the number of erroneous substitutions [$r=0.29$, $p<.005$] participants made during their free recall.

There are also significant correlations among the dependent variables. Not surprisingly, recognition results were strongly associated with all the qualitative measures of the free memory recall. These qualitative measures were also strongly inter-correlated with each another. Interestingly, the number of attributions subjects made about the story was strongly associated with all measures of memory recognition [$r=0.24$, $p<.05$] and recall [$r=0.50$, $p<.0001$] as well as the number of erroneous substitutions [$r=0.49$, $p<.0001$] and the number of fictitious additions [$r=0.36$, $p<.0005$] made during free recall. but the less fictitious additions [$r=-0.20$, $p<.05$] they made. The results also showed that the number of erroneous substitutions were often associated with measures of memory recall (for e.g., overall recall results, central basic visual elements, central and background details). Surprisingly, despite the fact that the number of

fictitious additions was associated with the number of erroneous substitutions [r=0.36, p<.0005] made, the better participants performed on the recognition task [r=-0.20, p<.05] and central gist measure of the recall task [r=-0.24, p<.01], the fewer additions they would make in their rendition of the story.

The results also showed that the more erroneous substitutions subjects made, the more emotional they rated the story [r=0.19, p<.05] and the more fictitious additions they made about the story, the more interesting they found the story [r=0.19, p<.05]. These observations were particularly noteworthy, considering the measures of interest and emotionality of story were significantly correlated with one another [r=0.53, p<.0001] and are possibly constructs that may have been confounded in the context of this study.

In accordance with the rationale supporting this study, the measures of story emotionality strongly correlated with the ratings of the background sounds' disruptiveness [r=0.41, p<.005] and distractibility [r=0.43, p<.005]. As mentioned earlier, these two measures were significantly correlated [r=0.62, p<.0001] and may actually be confounded in the context of this study. However, in accordance with the predicted results, the sounds' disruptiveness [r=-0.32, p<.05] not distractibility appeared to impinge on the recognition test performance of participants.

Ratings of the sounds' pleasantness and calmness were significantly correlated [r=0.50, p<.001], suggesting that they may be measuring the same construct. The results showed that the more calming you found the sounds to be, the more interesting you found the story and the higher you scored on the SSMS scale.

DISCUSSION

The experimental manipulations that were proposed in this dissertation were successfully implemented. Indeed, the participants who viewed the emotional version of the slide show had a greater emotional reaction than did the participants who viewed the neutral version of the story. As well, the group that was exposed to the emotional sounds had a greater emotional reaction than the group who was simply exposed to neutral background sounds. Essentially, this study was able to compare memory of emotional stimuli with the memory of neutral stimuli in an emotional environmental context. The following sections will briefly review the main results and discuss their implications with regards to the literature review and the eyewitness context.

Overall, the results of the present dissertation not only confirm the findings of previous researchers but also largely support the proposed hypotheses. Generally speaking, arousal was found to improve memory performance. Actually, this general statement needs some qualification. The beneficial effects of arousal on memory were revealed only for memory recall and were absent in all recognition measures. This finding closely parallels the findings of earlier researchers (Cahill & McCaugh, 1995; Christianson & Loftus, 1991; Christianson & Nilsson, 1989; Heuer & Reisberg, 1990; Mandler, 1993) who have consistently found arousal's beneficial effects exclusively for recall measures and finding instead that recognition measures are relatively immune to the effects of arousal. Also, the results showed that the beneficial effects of arousal were only found after a relatively long delay (i.e., one week). Again, this finding corresponds exactly to the findings of earlier researchers (e.g., Bradley, 1994; Bradley & et al., 1992; Burke et al., 1992;Farley & Grant, 1976; Millar, Styles & Wastell,

1980). This is most probably due to the fact that upon immediate recall, subjects' memory reaches a ceiling level with regards to accuracy and thoroughness.

The results showed that the beneficial effects of arousal were found to be most pronounced for central events, an observation that has also been reported by many previous researchers (e.g., Burke et al., 1992; Heuer & Reisberg, 1990). Interestingly, the present results also revealed that arousal improved the recall of peripheral background details, a finding that has not been reported in the literature. As a matter of fact, the few researchers who have actually examined this particular question, have instead reported that arousal was advantageous for central details to the detriment of background details (e.g., Heuer & Reisberg, 1990). The present findings are in direct contradiction to these claims. However, given the paucity of researchers who have studied this question, more replications are needed to draw meaningful generalizations about the processes of memory for arousal with regards to detailed information. The findings would have major implications for the eyewitness context where the main issue of interest for investigators revolves around central details not background details.

Based on previous findings, researchers (e.g., Cahill & McCaugh, 1995; Heuer & Reisberg, 1990) had also reported a phase by phase effect of arousal on memory. According to their results, they claimed that arousal appears to manifest its beneficial effects on memory only in the phase of the story that was temporally associated with the arousing nature of the stimuli. The present dissertation failed to replicate these claims, finding instead that arousal affected memory of arousing stimuli uniformly across the different phases of the story.

The research context such as the one discussed in this dissertation has an undisputed advantage over the field setting in that researchers know invariably and completely what the truth is. Thanks to this unique advantage of

the research context, a close examination of the errors committed by participants was possible in the present study. The results showed that arousal reliably and significantly increased all types of intrusions participants made during their recall of the story, including substitutions, fictitious additions and attributions. It is true that the productivity level of participants viewing the arousing version of the story was higher than that of the other participants. With this increased productivity, however, came an increased level of inaccurate information (i.e., as much as 30% of participants' recall consisted of intrusions) that was easy to tease apart in a research context such as this one but would be close to impossible to differentiate in an eyewitness context.

The only measure found in the present study that would help predict participants' production rate of factual elements in comparison to memory intrusions is a cognitive capacity for imagery and imaginative thinking. Higher scores on this measure tend to be associated with a higher number of memory intrusions. Perhaps, the cognitive capacity of imaginative thinking predisposes individuals to false elaborations of information recall (e.g., Laurence et al., 1986). This finding is not surprising in light of the literature review on individual differences with regards to hypnotizability and its associated cognitive measures and confabulation and memory accuracy (e.g., Laurence et al., 1986; Lynn & Nash, 1994; McCann & Sheehan, 1988; Statham & Jamieson, 1991b).

Other noteworthy advantages to studying memory in a controlled research setting that are not otherwise available in a field setting context include the slower pace of the events and the absence of extraneous factors. Indeed, the pace of the slide show used in this study is far slower than that of a real life situation. Previous research had already shown that the combination of arousal and fast pace is detrimental to any type of memory retrieval (Lang et al., 1999). Also, while participants in this study viewed the emotional version of the slide

show, the environmental context was ideal for memory retention. Participants sat in a quiet and dark room where their attention was only focused on the slide show. As soon as neutral non-specific background environmental sounds reminiscent of a public area were introduced to participants, their memory recognition and recall drastically deteriorated. Indeed, at all phases of the story regardless of retention interval, recognition results were universally hindered by the presence of background sounds, even when these sounds were simply neutral non-specific sounds. Results of the recall measures showed that neutral background sounds deteriorated overall recall, especially for the recall of central events. The neutral background sounds did not, however, affect the number of slides participants visually recalled nor did it affect the number of background details recalled.

The most significant new finding of the present study is the observation that the source of arousal plays a pivotal in the relation between arousal and memory. The present results add further limitations to the observation that arousal improves recall memory, especially for central events and background details, after a delay. The results clearly illustrate that arousal only improves memory when it is inherently part of the TBR material. Given the design of the present study, theoretically meaningful comparisons consist of comparing the memory performances between the group exposed to the arousing sounds and the group exposed to the neutral non-specific background sounds. Close examination of the memory differences between these two groups could potentially reveal the effects of an arousing environmental context on memory without the confound of arousing stimuli.

The results clearly illustrated that when arousal is part of the context in which the events are taking place, it hinders memory recall and to a lesser extent memory recognition, regardless of retention intervals. Interestingly, recognition

measures were again relatively immune to the effects of an arousing context, revealing instead an overall pattern of deterioration with the presence of environmental sounds, regardless of whether they were arousing or non-specific. An arousing context, however, negatively affected the overall number of slides participants visually recalled, especially in phase 1 of the slide show. This is probably due to a habituation effect for participants. Also, an arousing context especially impaired the recall of central events and central visual elements. In other words, it would appear that from these preliminary results, memory of emotional stimuli is quite different from memory of neutral stimuli while in an emotional state. Implications for the eyewitness context are that a passive witness of a crime will tend to be a more reliable reporter of the events than a crime victim, unless witnessing the crime events placed them in an emotional state of mind. The only study to date that has examined the specific issue regarding the source of arousal has found very comparable findings to the present findings (Libkuman et al., 1999).

Collectively, the implications of these results are highly significant for the eyewitness context. According to these and earlier results, the arousing nature of the stimuli that crime witnesses are exposed to, renders the events more memorable and the witnesses more reliable sources of accurate information, especially for facts about central events and background details. This beneficial effect of arousal is limited to relatively delayed recall (i.e., one-week). Little is known about the effects of arousal on memory given repeated recall over time and given directed questioning by investigators. However, given the higher probability that arousal increases the likelihood of memory intrusions, special care must be taken to ensure corroboration as well as particular individual characteristics such as imaginative thinking before conclusive generalizations are reached. As well, the present results strongly suggest that the emotional

state of a witness during the events can potentially hinder their recall of the events. Few investigators ever consider the emotional involvement of witnesses, assuming instead that an involvement renders the events more memorable.

It is interesting to note that the performance of the group exposed to the arousing sounds was consistently inferior to that of the group viewing the arousing story. Further research should replicate the present findings and examine memory for arousing stimuli under arousing conditions in order to find out if the hindering effects of the latter are counterbalanced by the beneficial effects of the former.

A number of limitations in the present study restrict the extent to which generalizations can be drawn. First, the ratio between men and women was disproportionally unequal in this study. This imbalance is further compounded by the observation that emotionality or arousal actually interacts with gender in that women appear to generally experience more emotionality to the slide show than men do. Secondly, although the intent in the present study was to examine incidental memory, the setting and the instructions may have made it too clear for volunteers that their memory was being tested. As a matter of fact, a number of participants had to be dropped from the study when they disclosed at the debriefing that they had correctly guessed early on that their memories would be tested. Finally, despite numerous efforts to experimentally control various extraneous variables in the present study, the construct of arousal level of story was confounded with the interest level of the story. As well, the emotional nature of the environmental sounds was also confounded with their level of distraction. Replications of the present findings without the presence of these limitations are warranted.

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APPENDIX A

SPEECH FOR RECRUITMENT IN CLASS

My name is ..... and I am working in Dr Laurence's and Perry's lab. The research that is carried out in this lab covers mainly three areas: how people remember events in general, hypnotic phenomenon, and how beliefs are formed.

The study I came here to talk to you about is for a doctoral dissertation and is looking at how people remember events in relation to some personality characteristics.

If you are interested in participating I will pass out a sheet where you may write you name and phone number and best time to reach you and either (Daniela or MJ) or myself will contact to set an appointment for testing at a time at your convenience.

This is a good oportunity for those of you who are interested in psychology to get first hand experience of how studies are conducted in this area, and even more so because later you will be doing similar things.

APPENDIX B

LIST OF ONE-SENTENCE NARRATIVES ACCOMPANYING EACH SLIDE:

Slide number	AROUSAL VERSION	NEUTRAL VERSION
1	A mother and son are leaving home in the morning	A mother and son are leaving home in the morning
2	She is taking him to visit his father's workplace	She is taking him to visit his father's workplace
3	The father is a laboratory technician in a nearby hospital	The father is a laboratory technician in a nearby hospital
4	They check before crossing a busy road	They check before crossing a busy road
5	While crossing the road, the boy is caught in a terrible accident which critically injures him	While crossing the road, the boy sees a minor accident which he finds interesting
6	At the hospital, the staff prepare the emergency room, to which the boy is rushed	At the hospital, the staff are preparing for a practice emergency drill, which the boy will watch
7	All morning long, a surgical team struggled to save the boy's life	All morning long, a surgical team practiced the disaster drill procedures
8	Specialized surgeons were able to re-attach the boy's severed feet	Make-up artists were able to create realistic looking injuries on actors for the drill.
9	After the surgery, while the father stayed with the boy, the mother left to phone her other child's preschool	After the drill, while the father stayed with the boy, the mother left to phone her other child's preschool
10	Feeling distraught, she phones the preschool to tell them she will soon pick up her child	Running late, she phones the preschool to tell them she will soon pick up her child
11	Heading to pick up her child, she hails a taxi at the number 9 bus stop	Heading to pick up her child, she hails a taxi at the number 9 bus stop

APPENDIX C

LIST OF AROUSING ENVIRONMENTAL SOUNDS AND THEIR DURATION

Woman's scream	6 seconds
Baby's crying	38 seconds
Babies' crying	38 seconds
Man coughing	17 seconds
Dentist's drilling	22 seconds
Cats' growling	22 seconds
Jackhammer	23 seconds
Dog's barking	26 seconds

APPENDIX D

QUESTIONS ABOUT THE BACKGROUND SOUNDS:

We would like you to rate the auditory sounds you heard, on the following attributes:

0 1 2 3 4 5 6 7 8 9 10
not distracting very distracting

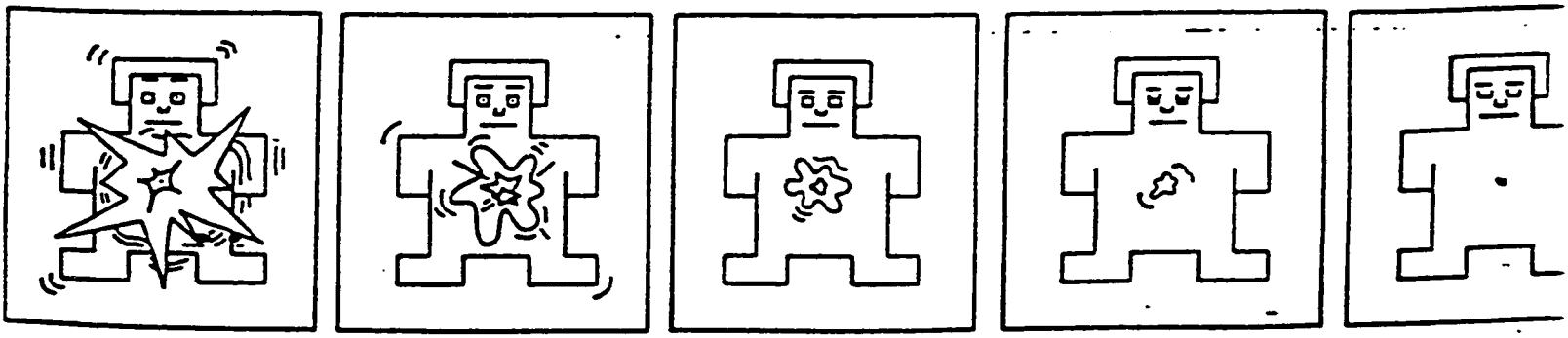
0 1 2 3 4 5 6 7 8 9 10
not upsetting very upsetting

0 1 2 3 4 5 6 7 8 9 10
not pleasant very pleasant

0 1 2 3 4 5 6 7 8 9 10
not calming very calming

0 1 2 3 4 5 6 7 8 9 10
not exciting very exciting

Please chose the figuring that best represents your reaction to the auditory sounds. Chose the figurine by placing an X on any figurine or between the figurines:



Please try to identify as many of the sounds as possible:

_____

_____

_____

_____

_____

APPENDIX E

THE AUTOBIOGRAPHICAL MEMORY QUESTIONNAIRE

Name: _____ Date: _____

THE AMQ QUESTIONNAIRE

Please decide whether you agree or disagree with each statement below. Indicate the extent to which you agree or disagree by circling the appropriate number on the scale.

1 STRONGLY DISAGREE	2 DISAGREE	3 NEITHER DISAGREE NOR AGREE	4 AGREE	5 STRONGLY AGREE

1. When I remember events from my past, it feels as though I can remember all the details of those experiences.	1	2	3	4	5
2. When I reminisce with friends or family about experiences we have shared in the past, I find that I can remember the details of those events much better than they can.	1	2	3	4	5
3. In general, I have difficulty remembering experiences from my past.	1	2	3	4	5
4. I feel that the memories I have about my high school years are vivid and very accurate.	1	2	3	4	5
5. My memory for my first days of elementary school are clear and I can remember many of the thoughts and feelings that I had.	1	2	3	4	5
6. When I look at photographs taken of myself in childhood, I have difficulty remembering when and where a particular photograph was taken and the events that were happening at the time.	1	2	3	4	5
7. I have a clear memory for some of my birthdays in my childhood.	1	2	3	4	5
8. I can call to mind experiences from my past very easily whenever I want.	1	2	3	4	5
9. When people tell me about something that I said or did in the past, I usually remember it well.	1	2	3	4	5

10. If I were to try, I could probably remember almost everything I have done in the past three years.	1	2	3	4	5
11. Memories from my past often enter my mind "out of the blue" without me even having to try.	1	2	3	4	5
12. I have a very good memory for most of the things I did when I was sixteen years old.	1	2	3	4	5
13. My memory for the feelings or emotions I have had during different experiences in my life are particularly vivid and clear.	1	2	3	4	5
14. I find it very easy to remember most of the things I did in my childhood.	1	2	3	4	5
15. I usually remember even the most I tend to only remember very significant, important or meaningful events from my past (e.g., tragic events, great accomplishments, or surprises etc.)	1	2	3	4	5
16. I am sometimes quite amazed by the accuracy and clarity of memory for experiences in my life.	1	2	3	4	5
17. If I were to try, I could probably remember some of the things that happened to me before I was three years old.	1	2	3	4	5
18. My memory of my past is almost like a book that I can open and look through whenever I wish.	1	2	3	4	5
19. I find it easy to remember the things I thought about and believed when I was an adolescent.	1	2	3	4	5
20. I find it quite difficult to remember how I felt or the emotions I had when I was a child.	1	2	3	4	5
21. I usually remember even the most "everyday" or neutral experiences my life.	1	2	3	4	5

APPENDIX F

TELLEGEN'S ABSORPTION SCALE

Name:_____Date:_____

Absorption : Scale Ab
Auke Tellegen, Ph.D.
University of Minnesota, 1978

In this booklet you will find a series of statements a person might use to describe his or her characteristics. Each statement is followed by two choices--True and false. Read the statement and decide which choice better describes you. Then circle your answer beside each statement.

Please answer every statement, even if you are not completely sure of the answer. Read each statement carefully, but do not spend too much time deciding on the answer.

1. Sometimes I feel and experience things as I did when I was a child.	TRUE	FALSE
2. I can be greatly moved by eloquent or poetic language.	TRUE	FALSE
3. While watching a movie, a television show, or a play, I may become so involved that I forget about myself and my surroundings and experience the story as if it were real and as if I were taking part in it.	TRUE	FALSE
4. If I stare at a picture and then look away from it, I can sometimes "see" an image of the picture, almost as if I were still looking at it.	TRUE	FALSE
5. Sometimes I feel as if my mind could envelop the whole world.	TRUE	FALSE
6. I like to watch cloud shapes change in the sky.	TRUE	FALSE
7. If I wish, I can imagine (or daydream) some things so vividly that they hold my attention as a good movie or story does.	TRUE	FALSE
8. I think I really know what some people mean when they talk about mystical experiences.	TRUE	FALSE
9. I sometimes "step outside" my usual self and experience an entirely different state of being.	TRUE	FALSE

10. Textures such as wool, sand, wood sometimes remind me of colors or music.	TRUE	FALSE
11. Sometimes I experience things as if they were doubly real.	TRUE	FALSE
12. When I listen to music, I can get so caught up in it that I don't notice anything else.	TRUE	FALSE
13. If I wish, I can imagine that my body is so heavy that I could not move it if I wanted to.	TRUE	FALSE
14. I can often somehow sense the presence of another person before I actually see or hear him or her.	TRUE	FALSE
15. The crackle and flames of a wood fire stimulate my imagination.	TRUE	FALSE
16. It is sometimes possible for me to be completely immersed in nature or in art and to feel as if my whole state of consciousness has somehow been temporarily altered.	TRUE	FALSE
17. Different colors have distinctive and special meanings for me.	TRUE	FALSE
18. I am able to wander off into my own thoughts while doing a routine task and actually forget that I am doing the task, and then find a few minutes later that I have completed it.	TRUE	FALSE
19. I can sometimes recollect certain past experiences in my life with such clarity and vividness that it is like living them again or almost so.	TRUE	FALSE
20. Things that might seem meaningless to others often make sense to me.	TRUE	FALSE
21. While acting in a play, I think I could really feel the emotions of the character and "become" him or her for the time being, forgetting both myself and the audience.	TRUE	FALSE
22. My thoughts often don't occur as words but as visual images.	TRUE	FALSE
23. I often take delight in small things (like the five-pointed star shape that appears when you cut an apple across the core or the colors in soap bubbles).	TRUE	FALSE

24. When listening to organ music or other powerful music, I sometimes feel as if I'm being lifted into the air.	TRUE	FALSE
25. Sometimes I can change noise into music by the way listen to it.	TRUE	FALSE
26. Some of my most vivid memories are called up by scents and smells.	TRUE	FALSE
27. Certain pieces of music remind me of pictures or moving patterns of colors.	TRUE	FALSE
28. I often know what someone is going to say before he or she says it.	TRUE	FALSE
29. I often have "physical memories"; for example, after I've been swimming I may still feel as if I'm still in the water.	TRUE	FALSE
30. The sound of a voice can be so fascinating to me that can just go on listening to it.	TRUE	FALSE
31. At times I sometimes feel the presence of someone who is not physically there.	TRUE	FALSE
32. Sometimes thoughts and images come to me without the slightest effort on my part.	TRUE	FALSE
33. I find that different odors have different colors.	TRUE	FALSE
34. I can be deeply moved by a sunset.	TRUE	FALSE

APPENDIX G

INDIVIDUAL DIFFERENCES QUESTIONNAIRE

Individual Differences Questionnaire (from Paivio, 1971)

Name:_____ Date:_____

The statements on the following pages represent ways of thinking, studying and problem solving. No two statements are exactly alike, so consider each statement carefully before answering. You are asked to rate each item on a 5-point scale which relates to how characteristic the statement is of you. Circling a rating of-2 indicates that the statement is extremely uncharacteristic of you, a rating, of +2 indicates that the statement is extremely characteristic of you, a rating of 0 indicates that the statement is neither characteristic nor uncharacteristic of you.

It is important that you answer as frankly and as honestly as you can. Your answers will be kept in the strictest confidence.

-2	-1	0	+1	+2
Extremely Uncharacteristic				Extremely Characteristic

1.	Listening to someone recount their experiences does not usually arouse mental pictures of the incidents being described.	-2	-1	0	+1	+2
2.	By using mental pictures of the elements of a problem, I am often able to arrive at a solution.	-2	-1	0	+1	+2
3.	I enjoy visual arts, such as paintings, more than reading.	-2	-1	0	+1	+2
4.	My daydreams are so vivid I feel as though I actually experience the scene.	-2	-1	0	+1	+2
5.	I do not have a vivid imagination.	-2	-1	0	+1	+2
6.	I can easily picture moving objects in my mind.	-2	-1	0	+1	+2
7.	I can form mental pictures to almost any word.	-2	-1	0	+1	+2
8.	I have only vague visual impressions of scenes I have experienced.	-2	-1	0	+1	+2
9.	I think that most people think in terms of mental pictures whether they are completely aware of it or not.	-2	-1	0	+1	+2

10. My powers of imagination are higher than average.	-2	-1	0	+1	+2
11. I can close my eyes and easily picture a scene I have experienced.	-2	-1	0	+1	+2
12. When someone describes something that happens to them I find myself vividly imagining the events that happened.	-2	-1	0	+1	+2
13. I seldom dream.	-2	-1	0	+1	+2
14. I never use mental pictures or images when trying to solve problems.	-2	-1	0	+1	+2
15. I find it difficult to form a mental picture of anything.	-2	-1	0	+1	+2
16. My dreams are extremely vivid.	-2	-1	0	+1	+2
17. My thinking often consists of mental pictures or images.	-2	-1	0	+1	+2
18. My daydreams are rather indistinct and hazy.	-2	-1	0	+1	+2
19. I enjoy the use of mental pictures to reminisce.	-2	-1	0	+1	+2
20. I often use mental images or pictures to help me remember things.	-2	-1	0	+1	+2
21. I do not form a mental picture of people or places while reading of them.	-2	-1	0	+1	+2

APPENDIX H

SNYDER'S SELF-MONITORING SCALE

Name: _____ Date: _____

SSM SCALE

The statements below concern your personal reactions to a number of different situations. No two statements are exactly alike, so consider each statement carefully before answering. If a statement is TRUE or MOSTLY TRUE as applied to you, circle **T**. If a statement is FALSE or NOT USUALLY TRUE as applied to you, circle **F**.

1. I find it hard to imitate the behavior of other people.	**T**	**F**
2. My behavior is usually an expression of my true feelings, attitudes, and beliefs.	**T**	**F**
3. At parties and social gatherings, I do not attempt to do or say things that others will like.	**T**	**F**
4. I can only argue for ideas which I already believe.	**T**	**F**
5. I can make impromptu speeches even on topics about which I have almost no information.	**T**	**F**
6. I guess I put on a show to impress or entertain people.	**T**	**F**
7. When I am uncertain how to act in a social situation, I look to the behavior of others for cues.	**T**	**F**
8. I would probably make a good actor.	**T**	**F**
9. I rarely seek advice of my friends to choose movies, books, or music.	**T**	**F**
10. I sometimes appear to others to be experiencing deeper emotions than I actually am.	**T**	**F**
11. I laugh more when I watch a comedy with others than when alone.	**T**	**F**
12. In a group of people I am rarely the center of attention.	**T**	**F**
13. In a different situations and with different people, I often act like very different persons.	**T**	**F**
14. I am not particularly good at making other people like me.	**T**	**F**
15. Even if I am not enjoying myself, I often pretend to be having a good time.	**T**	**F**

16. I'm not always the person I appear to be. T F

17. I would not change my opinions (or the way I do things) in order to please someone else or win their favor. T F

18. I have considered being an entertainer. T F

19. In order to get along and be liked, I tend to be what people expect me to be rather than anything else. T F

20. I have never been good at games like charades or improvisational acting. T F

21. I have trouble changing my behavior to suit different people and different situations. T F

22. At a party I let others keep the jokes and stories going. T F

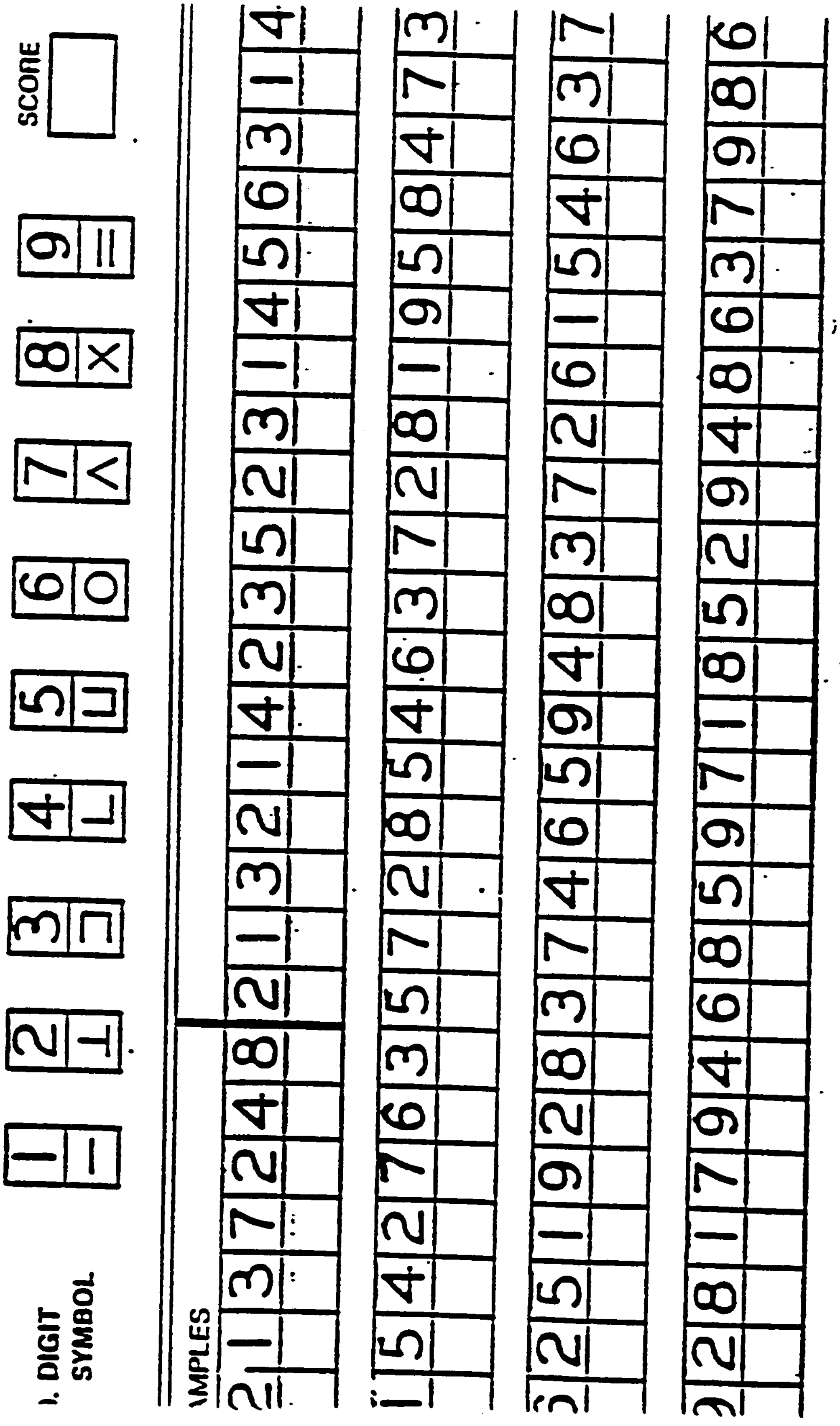
23. I feel a bit awkward in company and do not show up quite so well as I should. T F

24. I can look anyone in the eye and tell a lie with a straight face (if for a right end). T F

25. I may deceive people by being friendly when I really dislike them T F

APPENDIX I

THE DIGIT SYMBOL TEST



APPENDIX J

CONSENT FORM TO PARTICIPATE IN RESEARCH

Department of Psychology, Concordia University
Marie-Josee Gendron, M.A. & Jean-Roch Laurence, Ph.D.
assisted by Daniela Maestri, M.A.

Since you have been instructed about the study in detail, we ask you to sign this consent form. The experiment that you are about to participate in focuses on the relationship between certain personality characteristics and how people make sense of a story as well as the effects of auditory sounds on how people understand a story. Your task is to view a series of slides for about 5 minutes after which you will be asked to complete some questionnaires about yourself. Some of you will be asked to return in one week to watch another slide show. Each session will take about 30 minutes.

I understand that I may ask any questions about the experiment prior to signing this consent form.

I understand that participation in this experiment is voluntary, and that if I refuse to participate it will not prejudice my potential participation in other experiments in the Department of Psychology.

I understand that my participation in this experiment is anonymous and that my data will remain confidential even though the results of the experiment may be published.

I understand that this experiment is part of a program of studies and that I may be invited to participate in future studies. I understand that I may accept or refuse future invitations at my own discretion without prejudice.

I understand that I am participating in this research to advance the understanding of human psychology.

I understand that the two sessions of the entire experiment will last approximately one hour (60 minutes), that I will access to the results of the experiment at the end of the study and that I am free to discontinue my participation at any time.

I understood this agreement, and I freely consent and agree to participate in the experiment conducted by Marie-Josee Gendron and Daniela Maestri, under the supervision of Dr. J-R. Laurence.

Name: _____ Sex: _____ Age: _____

Signature: _____ Date: _____

APPENDIX K

LIKERT-SCALES HANDED TO PARTICIPANTS WITH AND WITHOUT BACKGROUND SOUNDS

Name: _____ **Date:** _____

Questions about the slide show
(given to all group with and without background sounds)

On a scale of 0 (=not at all) to 10 (=completely), how well do you feel you understood the story? Please circle the number corresponding to your answer.

0 1 2 3 4 5 6 7 8 9 10
not at all completely

On a scale of 0 (=not emotional) to 10 (=highly emotional), how emotional did you find the story to be? Please circle the number corresponding to your answer.

0 1 2 3 4 5 6 7 8 9 10
not emotional highly emotional

On a scale of 0 (=not interesting) to 10 (=very interesting), how interesting did you find the story to be? Please circle the number corresponding to your answer.

0 1 2 3 4 5 6 7 8 9 10
not interesting very interesting

NAME: _____ **DATE:** _____

Questions about the slide show
(given to groups with background sounds)

On a scale of 0 (=not at all) to 10 (=completely), how well do you feel you understood the story? Please circle the number corresponding to your answer.

0 1 2 3 4 5 6 7 8 9 10
not at all completely

On a scale of 0 (=not emotional) to 10 (=highly emotional), how emotional did you find the story to be? Please circle the number corresponding to your answer.

0 1 2 3 4 5 6 7 8 9 10
not emotional highly emotional

On a scale of 0 (=not interesting) to 10 (=very interesting), how interesting did you find the story to be? Please circle the number corresponding to your answer.

0 1 2 3 4 5 6 7 8 9 10
not interesting very interesting

We would like you to rate the auditory sounds you heard, on the following attributes:

0 1 2 3 4 5 6 7 8 9 10
not distracting very distracting

0 1 2 3 4 5 6 7 8 9 10
not upsetting very upsetting

0 1 2 3 4 5 6 7 8 9 10
not pleasant very pleasant

0 1 2 3 4 5 6 7 8 9 10
not calming very calming

APPENDIX L

THE RECOGNITION TEST

Thematic Arousal Study: Recognition memory test, 11 slide version

Questions and possible answers are read to subjects. Subjects are told that they must answer "even if you are forced to guess, and you will have to guess on many of them because we have designed it to be difficult". (This is said to allay their fears about not knowing answers and having to guess).

They are told that there will be 5 -9 questions per slide, and that they will be told at what point the questions will refer to the next slide so that they will always know to which slide (out of 11 total, in this new version) a question refers. They are further told that "sometimes a question will tell you that you were right or wrong on a previous question, if you were right, great, if you were wrong, just keep going on".

1:1
Who is pictured in slide 1?
a) a mother and her son
b) a father and his son
c) a mother and father
d) no one is pictured

1:2
What are the mother and son doing?
a) eating at a table
b) leaving home
c) walking
d) riding in a car

1:3
Where are the mother and son standing?
a) in front of a school
b) in front of their home
c) at a bus stop
d) next to their car

1:4
What is the mother doing?
a) locking the house door
b) tying her son's shoe
c) getting into her car
d) standing in a doorway

1:5
What is the color of the house door?
a) green
b) black
c) red
d) blue

1:6
What is visible in the foreground of the picture?
a) lawn
b) trees
c) steps
d) driveway

1:7
What is the boy carrying?
a) soccer ball
b) his lunch
c) a backpack
d) a teddy bear

1:8
What time of day is it?
a) morning
b) afternoon
c) evening
d) was not mentioned

2:1
Who is pictured in slide 2?
a) mother
b) son
c) mother and son
d) mother and son and one other person in background

2:2
What are they doing?
a) standing
b) sitting
c) walking
d) running

2:3
Where are they going?
a) to school
b) shopping
c) father's workplace
d) mother's workplace

2:4
What is their position relative to each other?
a) walking arm in arm
b) walking hand in hand
c) he is holding her jacket
d) there is no contact between them

2:5
What is their position relative to each other from the fri:)m the viewers perspective?
a) he is on the left
b) he is on the right
c) he is in front of her
d) he is behind her

2:6
You were told that they
a) had long planned to do this
b) did it in the spur of the moment
c) did it after receiving a phone call
d) no such information was given

2:7
Their facial expression is:
a) neutral
b) sad
c) happy
d) excited

2:8
How much of the child can you see?
a) full body
b) shoulder up
c) waist up
d) knees up

2:9
Which direction are they walking relative to the viewer?
a) towards the viewer
b) away from the viewer
c) to the left
d) to the right

Slide 3:1
Who or what is pictured next?
a) the mother and son
b) the father
c) all three
d) a hospital

3:2
You were told that the father's occupation is
a) a school teacher
b) a surgeon
c) laboratory technician
d) hospital custodian

3:3
What is the father doing in this slide?
a), working at a lab bench
b) looking into a microscope
c) sweeping the floor
d) posing, looking directly at the camera

3:4
Relative to the viewer, he faces
a). left
b) right
c) directly towards the viewer
d) away from the viewer

3:5
Pictured in the background is
a) a microscope
b) a door
c) a window
d) some chemicals

3:6
The father has
a) glasses
b) beard
c) both
d) neither

Slide 4:1
Who is pictured in the next slide?
a) mother
b) mother and son
c) father and son
d) no one

4:2
What are the mother and son doing?
a) getting into a car
b) getting into a bus
c) waiting at a stoplight
d) checking before crossing the street

4:3
Which direction are they looking from the viewer's perspective
a) both left
b) both right
c) mother left and son straight ahead
d) mother right and son straight ahead

4:4
What is in the background?
a) trees
b) a house
c) a parked car
d) a bicycle

4:5
The boy stands where relative to the mom from viewer's perspective?
a) on the right
b) on the left
c) in front of her
d) behind her

4:6
They are standing next to a
a) street sign
b) parked car
c) stop light
d) telephone pole

Slide 5:1
What is pictured next?
a) an intersection
b) an ambulance
c) car off the road
d) tow-truck with a car

5:2
What happened in this slide?
a) the boy saw a bad accident happen
b) the boy was hit by a runaway car
c) the boy saw some wrecked cars in a junk yard
d) they walked past the scene of a minor accident

5:3
You were told that the boy:

(neutral)	(arousal)
a) was a little scared by the accident	a) was knocked unconscious
b) wanted to stop and look at the car	b) was critically injured
c) found the accident scene interesting	c) was trapped under the car
d) did not see the car	d) was mildly hurt

5:4 Who was visible in the slide?
a) mother
b) boy
c) some unnamed people
d) no one

5:5
The color of the car pictured was
a) green
b) grey
c) blue
d) brown

5:6
The car was facing
a) towards the viewer to the right
b) away from the viewer to the right
c) towards the viewer to the left
d) away from the viewer to the left

5:7 In addition to the car you could also see
a) an ambulance
b) a tow truck
c) other cars driving by
d) a parked car in the background

5:8
What was located in the foreground of the picture?
a) a bicycle
b) a fire hydrant
c) some broken glass
d) a water-sewer cover

5:9
The color of the hydrant was
a) white
b) yellow
c) red
d) two-toned

Slide 6:1 What is pictured next?
a) a tow truck
b) an ambulance
c) a busy street
d) a hospital

6:2
You were told that the hospital staff
a) prepared the emergency room for the boy
b) are working on victims of a bus crash
c) are preparing for a disaster drill
d) it was not mentioned

6:3
What is the color of the hospital ?
a) green
b) pale blue
c) grey
d) light brown

6:4
What is the name of the hospital?
a) Bannam County Hospital
b) County Hospital
c) Victory Memorial Hospital
d) St. Vincent's Hospital

6:5 What kinds of vehicles are pictured in front of the hospital?
a) cars
b) ambulances
c) supply trucks
d) none are pictured

6:6 How much of the hospital is visible?

a) ground floor only
b) ground floor and the second floor
c) many floors
d) many floors and the roof

Slide 7:1 What is pictured next?
a) mother
b) surgeons
c) father
d) nurses

7:2 Where are the surgeons pictured?
a) in an operating room
b) scrubbing for surgery
c) in a hallway
d) by a door

7:3 The surgeons were
a) talking with the boys parents
b) practicing drill procedures
c) working on the boy
d) it was not mentioned

7:4 What persons were visible?
a) boy and surgeons
b) several surgeons in background
c) several surgeons in background and one in foreground
d) two surgeons in the foreground

7:5 The surgeon in the foreground is wearing
a) a surgical gown only
b) a surgical gown and surgical hat
c) glasses and surgical gown
d) al of these

7: 6 What is the expression on his face?
a) sad
b) happy
c) neutral
d) shocked

7:7 You were told that the surgeons worked
a) morning !ong
b) all day long
c) all afternoon long
d) it was not mentioned

Slide 8:1 What is pictured next?
a) doctors talking to nurses
b) father and mother
c) an actor in the drill (neutral)/// the boy after surgery (arousal)
d) the father and the boy

8:2 What had been done to the actor / boy?

(neutral)

a) he was put into a brain-scan machine

b) he was made-up to look like an accident victim

c) he was wheeled into the operating room for the drill

d) it was not mentioned

(arousal)

a) skin grafts were put on his legs

b) his feet were reattached

c) his broken legs were in a cast

d) it was not. mentioned

8:3 What part of the actor// boy is shown?
a) head only
b) whole body
c) legs only
d) torso only

8:4 Where were scars visible on the body?
a) on feet
b) near the ankles
c) on the knees
d) there were no scars visible

8:5 What else is pictured besides the actor / boy?
a) a surgical tool
b) an iv drug line
c) pillow
d) nothing

8:6 What is the position of the actor / boy?
a) lying on his stomach
b) lying on his back
c) lying on his side
d) sitting

Slide 9: 1 Who leaves the hospital?
a) the father
b) the mother
c) the mother and son
d) the mother and father

9:2
Why does the mother leave?
a) to call her parents
b) is late for her job
c) to call her other child's school
d) has an appointment

9:3
What is she holding in her hand?
a) her purse
b) her keys
c) soccer ball
d) nothing

9:4
What is she walking near?
a) a police station
b) a train station
c) a library
d) a sky-scraper

9:5
What is she walking towards?
a) a street light
b) a taxi stand
c) a street vendor
d) a telephone booth

9:6
Which way is she facing?
a) towards viewer
b) away from viewer
c) walking to left
d) walking to right

9:7
The mother's purse is where?
a) in her hand
b) over her shoulder
c) she is not carrying a purse

9:8
In the middle of the picture is a:
a) tall tree
b) stop sign
c) tall pole
d) garbage can

10:1
Where is the mother
a) in a police car
b) on a curb
c) in a telephone booth
d) getting into a taxi

10:2
Who does the mother call?
a) her parents
b) her boss
c) her child's school
d) the taxi company

10:3
What is she leaning on?
a) a soccer ball
b) her purse
c) a telephone book
d) the door

10:4
The phone is where relative to the mother from the viewer's perspective?
a) on the right
b) on the left
c) behind the mother
d) is not visible at all

10:5 The mother was described as
a) feeling tired
b) feeling distraught
c) running late
d) feeling anxious

11:1
Where is mother now?
a) at a bus stop
b) at a taxi stand
c) at home
d) outside her office building

11:2
What is she doing at the bus stop?
a) waiting for a bus
b) trying to hail a cab
c) crossing the street
d) looking for her keys

11:3 Where is she going?
a.) to speak with her child's teachers
b) to pick up her other child
c) to her parents house
d) it was not clear

11:4
What is pictured in the right foreground?
a) a stop sign
b) a bench
c) a speed limit sign
d) an approaching bus

11:5
What is the speed limit on the sign?
a) 25 mph
b) 15 mph
c) 30 mph
d) cannot be read

11:6
What is the number of the bus stop where she is waiting?
a) #3
b) #12
c) #9
d) #15

APPENDIX M

THE SCRIPT FOR TESTING SUBJECTS

Script for testing subjects

Thank you for taking part in this study. I'll just take a few minutes to tell you about the study and what your task will be.

We are interested in how certain personality characteristics relate to how people understand and react to a story.

[for those with audiotape]
[We are also interested in the effects of auditory sounds on how people make sense of a story].

So, what we're asking you to do today is to watch a series of slides as you would a movie. Each slide will be shown for approximately 15 seconds and the entire show will last about 5 minutes. Each slide will be accompanied by a descriptive sentence presented via audiotape. It is likely that you will find some of these slides pleasant, some unpleasant and some basically neutral. Pay attention to each slide. It is important that you pay attention and understand the slide show. There is nothing you need to do other than watch the slide show.

[for those with audiotape]
[Another audiotape will play some sounds while you're watching the slide show.

[for everybody]
After the slide show, we'll give you 4 personality questionnaires and an attentional task.

After this some of you will be asked to come back in one week while others will be asked to stay right now for the second part of the study. The second part, whether it is right away or in 1 week, consists of watching another slide show and it takes about 30 minutes. People are chosen completely at random.
Any questions? Ok, we'll ask you to sign the consent form and then we'll begin.

[slide show with audiotaped white noise or arousing environmental sounds]

Now, you'll fill out some questionnaires. There are a few questions about the story for you to respond to. Then, the 4 personality questionnaires measure things like abilities for absorption, imagery, social monitoring, memory and concentration abilities. There is no right or wrong answer. Just respond with the first thing that comes to your mind. Don't think too much about your answers and don't go back to the items after you responded. Just make sure you answer all the questions truthfully.
Please make sure you write your name on top of every single page.

[hand out the 4 questionnaires]

Now, there is a little task to complete just to give us an indication of your concentration level. It's called the Digit Symbol Test.
Make sure you write your name at the top of the page. You'll notice that under each number 1 to 9 inclusively, there is a specific symbol. Your task is to fill each empty square with the proper symbol and to complete as many squares as

possible in 90 seconds. Fill in the sample part for practice. **[wait]** The squares must be completed in a sequence, that is, you cannot complete all number 2's, all number 3's and so on. Once you have completed a line you must continue immediately on the second one. You are to stop immediately when I advise you to do so. Are you ready to begin? **[Start the test for 90 seconds]**

DO NOT TELL OTHERS ABOUT THE EXPERIMENT 'CAUSE YOUR CLASSMATES MAY ALSO BE VOLUNTEERS FOR OUR STUDY

Free recall task (immediate or one week later)

Thank you for [coming back] or [staying] for this second session. This time, I'll ask you some questions about the story. This is a bit of a surprise actually. In fact, we are not going to show you another slide show because we are really interested in memory. What we would like to do is to assess your memory for the slide show you saw (last week) or (just now). It does not matter if you remember a lot or a little, it only matters that we assess as completely as possible everything you remember from the slide show. We are going to test your memory in two ways. The first is a free recall test – that's where I turn on a tape recorder and you tell me everything you remember having seen or heard from the slide show (for example, colors of clothes people were wearing, or the direction people were walking). When you think you have remembered all you can, we'll go on to the second part of the memory test, which is a multiple choice recognition memory test. I'll read a question to you and four possible answers. Your job is to tell me what you think is the correct answer even if you have to guess, and you will have to guess on many because we have designed the test to be hard. Any questions? Ok, then let's begin with the free recall test. Tell me everything you can remember, both about the general story line (that is, what happened?) as well as any particular details you remember having seen or heard. You can take as much time as you need.

[when you think they have recalled all they can]

Ok., now I'd like to redirect your thinking a bit. I'll remind you that there a total of 11 slides, and we want to assess which of those 11 you have any memory of seeing. So for each slide that you remember seeing, describe it in as much details as you can so that we can say "ok, (s)he remembers that one" or "(s)he does not remember that one".

[recognition test]

Let's now move on to the recognition test. There will be 5 to 9 questions per slide, and I will begin with slide one, and move progressively on to the subsequent slides. For each question, there are 4 possible choices, just tell me your response. Try to answer all the questions even if you are forced to guess, and you will have to guess on many of them because we have designed it to be difficult. Sometimes a question will tell you that you were right or wrong on a previous question, if you were right, great, if you were wrong, just keep going on.

[read the 80 questions from the recognition test one by one]

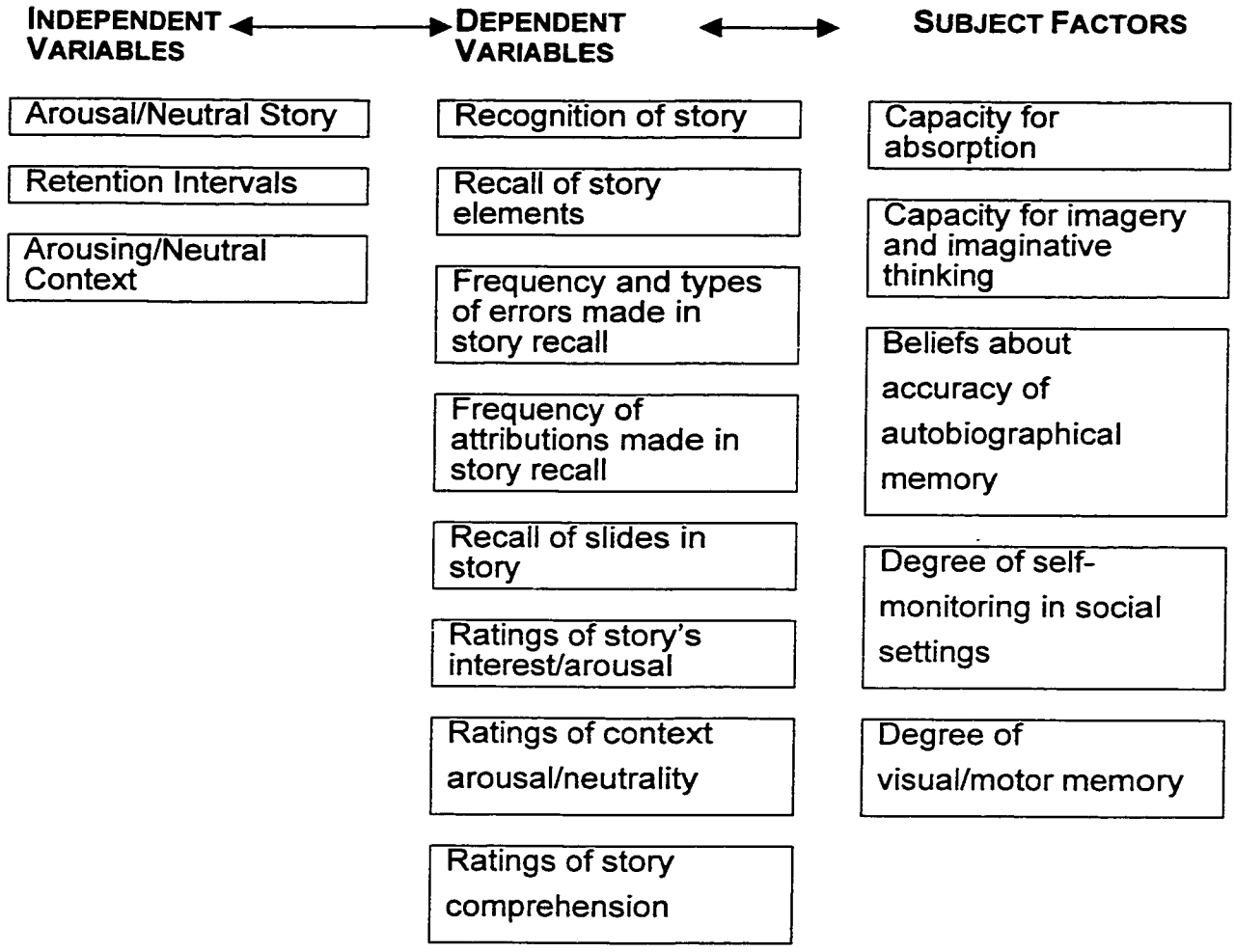
APPENDIX N

CODING CATEGORIES USED FOR ANALYSIS OF PARTICIPANTS' VERBATIM PROTOCOLS IN THE FREE RECALL TASK

Central Gist Information	Any element that would be included when narrating a story that would be considered gist (i.e., who, what, where of the story)
Central Basic-level Visual Information	Any element that would be included when describing what the slide showed (e.g., "the mother was *walking*").
Central Details	Detailed information that is related to central characters of the story, including peripheral information.
Background Details	Detailed information related to the background of slide.
Fictitious Additions made (central and details)	Additional elements made by participants including central and detailed information.
Erroneous Substitutions	Supplementary elements made by participants including central and detailed information.
Attributions	Attributional statements made by participants such as ascribing motivations to the story or its characters, exaggerations or judgments of the story elements (i.e, things that may be true but were not said).

APPENDIX O

LIST OF VARIABLES UNDER STUDY



APPENDIX P

CORRELATION TABLE MATRIX OF ALL THE MAIN VARIABLES UNDER STUDY

	TAS	IDQ	AMQ	SSMS	Story Arousal	Story Interest	Sounds' Disrupt	Sounds' Distract	Total recognition	Total recall	CG	CBV	DB	DC	Substitution count	Addition count
Attributions	.11	.22	.04	.18	.17	.18	-.01	.13	.24	.50	.24	.32	.47	.51	.49	.36
Additions	.10	.19	.09	.05	.15	.19	.05	-.06	-.20	-.07	-.24	-.17	.02	.05	.36	1.0
Substitutions	.16	.29	.00	.16	.19	.14	.15	.06	.13	.33	.18	.20	.34	.31	1.0	
DC	-.07	.04	-.04	.03	.12	.01	-.31	-.13	.65	.89	.42	.59	.69	1.0		
DB	.00	.06	.03	.12	-.04	.03	-.04	-.01	.64	.84	.44	.53	1.0			
CBV	.01	.06	.03	.06	-.02	.08	-.17	-.15	.81	.79	.65	1.0				
CG	-.01	-.07	-.15	.01	.09	.15	-.21	-.24	.66	.71	1.0					
Recall	-.03	.03	-.04	.06	.04	.07	-.25	-.16	.82	1.0						
Recognition	-.12	-.03	-.02	.04	.01	.03	-.32	-.19	1.0							
Sounds' Distraction	-.07	-.01	.00	.10	.43	.18	.62	1.0								
Sounds' Disruption	.02	.27	.17	.15	.41	.21	1.0									
Story Interest	.03	.02	-.03	.05	.53	1.0										
Story Arousal	-.07	.01	-.11	.12	1.0											
SSMS	.16	.15	0.0	1.0												
AMQ	.23	.26	1.0													
IDQ	.38	1.0														
TAS	1.0															

Legend for table: Abbreviations refer to the same abbreviations used in the text.
DC refers to Central Details
DB refers to Background Details
CBV refers to the Central Basic Visual elements
CG refers to the Central Gist elements
Significant results at $p<.05$ are identified as gray-filled cells