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Effects of imagery, arousal, and encoding strategy on free recall in a von Restorff study

Parker, Kinta Marie, Ph.D.

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28 times higher than the transfer constant reported for carbon tetrachloride in MMA polymerization (2.4×10^{-4}) but is three orders of magnitude lower than the transfer constant reported for n-butyl mercaptan. Phosphorus trichloride has the lowest transfer constant among the phosphorus chlorides listed in Table 8 for MMA polymerization (1.4×10^{-4}); the transfer constant for carbon tetrachloride is about twice as high as this. There were no data reported for the behavior chlorophosphines for styrene polymerization systems.

Pellon[12] related differences he observed in reactivity of the various phosphines toward MMA and styrene radicals to polar effects using the Alfrey-Price *Qe* scheme. The Alfrey-Price *Qe* scheme attempts to relate rates of the radical-monomer reactions to terms that reflect the intrinsic reactivity of monomers toward radicals (Q values) in the absence of polar effects and to terms (e values) that reflect the ability of radicals or monomers to donate (negative e values) or accept (positive e values) electrons toward a coreactant in the transition states for the addition of radicals to monomers.[16] For example, the monomer reactivity ratio for a monomer in a copolymerization system can be calculated by the following equation, where Q_1 and e_1 refer to monomer 1 and Q_2 and e_2 refer to monomer 2.

$$r_1 = Q_1/Q_2 \exp[-e_1(e_1-e_2)] \qquad (2)$$

EFFECTS OF IMAGERY, AROUSAL, AND ENCODING STRATEGY ON FREE RECALL IN A VON RESTORFF STUDY

by

KINTA MARIE PARKER

A DISSERTATION

Submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Psychology in the Graduate School, The University of Alabama at Birmingham

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ABSTRACT OF DISSERTATION
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Title Effects of Imagery, Arousal, and Encoding Strategy on Free Recall in a von Restorff Study

This study examined the effects of specific information processing strategies, imageability of verbal material, emotional arousal, and selected individual difference variables on free recall of words. Differences in free recall were examined in undergraduate students who were assigned one of three encoding strategies (rote rehearsal, separation imagery, relational imagery) or no specified encoding strategy. Word lists were presented that were either high or low in imagery value. Some word lists were high in arousal value, by amplification of a central item to a loud volume. Results indicated that high imagery words were recalled better than low imagery words and that arousal has the general effect of disrupting recall for preceding and succeeding material. Subjects assigned to imagery encoding strategies, however, demonstrated no impaired recall as a function of arousal. These results are interpreted as providing support for both a dual-coding approach to information processing as well as preliminary experimental support for the clinical use of imagery based therapy techniques with patient groups characterized by a high level of arousal.

Abstract Approved by: Committee Chairman Linda W. Duke

Program Director [signature]

Date 8/28/92 Dean of Graduate School W. A. [signature]

PS-5744

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"Imagination is more important than knowledge."

Albert Einstein

This dissertation and my completed passage through the Medical Psychology program reflect in large part the persistence and dedication of Linda Warren Duke. As needed over the years, she has been wise, stubborn, and supportive above and beyond the call of duty. I also thank Lee Shackleford and Sean McLoughlin, without whom this dissertation would never have been defended. I am grateful to them all.

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CE	critical event
db	decibels
GSR	galvanic skin response
HDL	Health and Daily Living Form
NI	neurotic introverts

INTRODUCTION

The current study is designed to examine the impact of emotional arousal and imagery on memory. The experimental paradigm involves free recall of words presented sequentially in a series of lists. Arousal is manipulated using a von Restorff paradigm in which an arousing event is embedded within the list. A previous study (Parker, 1990) identified a relationship between arousal and imagery, such that recall of words high in imagery value was disrupted by arousal to a greater extent than recall of low imagery words. This relationship of arousal and imagery interacted with an individual difference variable, suggesting that the effect of arousal on recall of high and low imagery material might be mediated by individual choice of encoding strategy. The current study was designed to distinguish between the effects of two aspects of "imagery"--imagery as a process or an encoding strategy, and imagery as an inherent characteristic of a word. Thus, the singular and interactive effects of encoding strategy, imageability of verbal material, emotional arousal, and individual differences in coping style on recall were examined in the present study.

This introduction will be presented in five parts. Section 1 is a selective review of the research literature on arousal and memory. Section 2 is a discussion of the major theoretical formulations based on this body of research. Section 3 includes a survey of literature on imagery, both as a characteristic of the stimulus and as an encoding strategy. Section 4 describes what is known about the relationship between imagery and arousal, with particular attention to earlier studies related in paradigm or theory to the current study. Section 5 describes the intent and overall design of the present study.

Section 1. Arousal Research

One of the factors most persistently studied in the memory literature is the effect of arousal on memory. Arousal has been defined in a multitude of ways, and its effects have been assessed in a plethora of different research designs. Arousal has been manipulated experimentally at both the input and output of the to-be-remembered material. It has also been examined as a subject variable. Memory itself has been assessed in paired associate learning tasks, list learning tasks, using free recall, cued recall and recognition; and the stimulus was material being paragraphs, sentences, words, pictures, bigrams, nonsense syllables or nonverbally encodable figures. The retention intervals in these studies have frequently been manipulated, and designs include repeated measures and between groups designs. The net effect of this diverse literature is to create a body of results that is difficult to integrate. Our primary focus for the present study is the effect of arousal within a free recall task.

Schwartz (1975) indicated that arousal can have either facilitatory or detrimental effects on memory. His research primarily concerned arousal as an individual difference variable. Using Eysenck's (1967) personality dimensions of introversion-extroversion and neurotic-stable, Schwartz predicted that those persons lowest in arousal (stable extroverts, or SE's) would utilize different processing cues than those highest in arousal (neurotic introverts, or NI's). This dimension had been previously used by McLaughlin and Eysenck (1967), who found that on a paired associate task requiring semantic encoding, low arousal subjects (SE's) performed better. Schwartz (1975) employed two paired associate tasks. In one task, all the response terms were semantically related, making the learning of stimulus-response pairs more difficult if the subject were to use semantic encoding. In the second paired associate task, the response terms were phonetically similar, theoretically causing interference if encoding the pairs was based on phonetic strategies. Thus, in the first task learning was facilitated by utilization of phonetic encoding, whereas in the second, encoding based on the meaning of the words would be most productive. Schwartz predicted that high arousal subjects (NI's) would perform better than low arousal subjects (SE's) on the list conducive to phonetic encoding. The converse was expected to be true for the list conducive to semantic encoding. These hypotheses were supported. A second experiment by Schwartz used subjects identified according to the same personality dimensions already described. In this study, however, the task was a free recall task, including clusters of words from the same semantic categories. The dependent variable was the organization of the recalled words. It was hypothesized that high arousal subjects would employ rote memorization of the lists, whereas the low arousal subjects would recall words in semantic clusters. These hypotheses were supported by the data: NI subjects, relative to the other groups, showed a decrease in semantic clustering and an increase in rote-ordered recall. These results support the contention that arousal, as a subject variable, is associated with the type of organization of verbal material in memory. In summary, Schwartz concluded that high arousal subjects focused on the physical aspects of the material, while the low arousal subjects organized material around semantic clues.

Christianson and Nilsson (1984) were interested in attempts to create amnesia as a function of experimentally induced arousal. They discussed three general models used to account for amnesia: disruptions in encoding, disruptions of consolidation, and disruptions of retrieval. Four studies were conducted to examine the singular and combined effects of these three factors in producing amnesia. The general design was presentation of a series of slides of faces, paired with slides containing words (names, occupations, hobbies, personality traits) to be associated with a given face. There were 18 slides per series, divided into three segments of six each. Experimental and control groups received identical slide pairs of ordinary human faces in the first and last series. The experimental group was exposed to severely disfigured faces of cadavers in phase two, while the control group again saw neutral faces. Psychophysiological data confirmed that high arousal was associated with perception of the disfigured faces. Using different combinations of recall and recognition trials, both free and cued, as well as varying the retention intervals, the authors were able to rule out any significant influence of disruption of consolidation as accounting for amnesia. Instead, the apparent effect of arousal was due to a disruption of both encoding and retrieval for material learned under conditions of high arousal. Arousal was shown to impair recall, but not recognition, for material presented subsequent to the arousing event (anterograde amnesia). The authors concluded that high arousal leads to shallower encoding as well as to a disruption of retrieval.

The work of Tulving (1969) is more closely related in paradigm to the current study. The purpose of his work was to create an experimental analogue to clinical amnesia. He presented subjects with a list of common nouns with a famous name in the central position of the list. This famous name was the critical event, or CE. Subjects were told that it was most important to remember the famous name but that they were also to remember as many of the words as they could. Subjects who were given a CE in the central position of the list had greater recall of the CE and poorer recall of the words just before and after the CE than did those subjects who were given lists with no CE in the central position. This phenomenon has been termed the "von Restorff effect" (Wallace, 1965), after the researcher who first showed that an isolated item against a homogeneous background was recalled better than other items (von Restorff, 1933). This general procedure has been employed in various ways to examine the effects of arousal on memory.

Redeiss (1986) employed a variation on Tulving's paradigm to distinguish between the effects of high and moderate arousal in a von Restorff paradigm. The CE was a vulgar or violent word in the high arousal condition and a famous name in the low arousal condition. Redeiss reported greater disruption of memory when the critical event was high in arousal value. Instructions to produce the CE first (high priority instructions) led to more profound amnestic effects of arousal than when no such directions were given. The memory impairment demonstrated in the von Restorff manipulation was not, however, dependent on high priority instructions with regards to the CE. So while the memory disruption due to the CE was enhanced by high priority instructions, it was not dependent upon them. Redeiss also found that the impact of arousal varied with the type of encoding strategy employed. This issue was addressed in the form of a post-experimental question. She asked subjects how they had attempted to learn the lists. The majority (79%) of her subjects reported using complex strategies, where the remainder reported using simpler strategies, such as rote rehearsal. Subjects using complex strategies had better overall recall but a stronger amnestic effect for words just prior to and following the critical event. This suggested that an individual's choice of encoding strategy in some way interacted with arousal in producing amnestic effects. In summary, Redeiss found 1) that high arousal leads to greater disruption of recall than moderate arousal within a von Restorff paradigm, 2) that high priority instructions enhance the amnestic effect of arousal, and 3) that complex encoding strategies are more vulnerable to the effects of emotional arousal than simpler ones. This is consistent with the work of Schwartz (1975), who found that higher arousal, as a subject variable, was associated with poorer performance on a task conducive to semantic encoding relative to performance on a task conducive to phonetic encoding.

Different effects of arousal on memory have emerged when other types of memory tasks have been employed. Arousal appears generally to compromise recall in paired-associate learning, at least when semantic encoding is used to learn pairs (Eysenck, 1976; Schwartz, 1975). Another area in memory research, reminiscence, is based on the hypothesis that while learned material is in general subject to the well established forgetting curve, material that is arousing in nature (or is learned under conditions of arousal) will be more poorly remembered immediately, but will be better remembered at some later time, than will neutral stimuli. However, the reminiscence literature has not fared well over time, with a history of replication problems and design difficulties (Eysenck, 1976; Keppel, 1982).

In the next section, the major theoretical models of arousal will be discussed in an effort to make some general statements that can integrate the above data with the larger body of research literature on arousal and memory.

Section 2. Arousal Theory

Major theories of arousal and memory differ in their focus with regard to the different processes involved, such as encoding and retrieval. Schwartz (1975), for example, focused almost exclusively on the way in which subjects' arousal affects the encoding process. Based on his own research, as well as a review of the literature on arousal and memory, he concluded that arousal can have either facilitative or detrimental effects on memory. The specific effect of arousal is dependent on the nature of the task to be performed. High arousal was associated with better recall of phonemically related or semantically unrelated verbal material, leading Schwartz to conclude that subjects characterized by high arousal would be more likely to focus on the physical, rather than the semantic, aspects of presented material.

In a similar vein, Eysenck (1976) summarized his review of the arousal and memory literature in this way:

> Most of the evidence at present appears to be consistent with the hypothesis that high levels of arousal affect storage by focusing attention on physical characteristics of the presented information, whereas high levels of arousal affect retrieval by biasing the

> subject's search process toward readily accessible stored information more than is the case with lower levels of arousal (p. 401).

Thus, in Eysenck's model, arousal has different effects on the various stages or processes involved in memory. According to this model, high arousal promotes storage based on physical characteristics. Arousal at the time of retrieval will cause search processes to be predisposed towards retrieval based on more easily accessed information, such as the physical characteristics of presented information.

In an effort to determine the locus of the effect that arousal has on memory, Christianson and Nilsson (1984) performed a series of experiments already cited to distinguish between the relative impact of disruptions of encoding, consolidation, and retrieval in experimental amnesia. Based on their review of the literature and their own studies, they concluded that experimentally produced anterograde amnesia is primarily a function of an encoding disruption. They did not examine the possible role of the type of material being encoded, so these findings may be somewhat limited in their generalizability.

Mandler (1975) also focused on the effects of arousal within the encoding processes. He explained the effects of arousal within a limited capacity model of attention and consciousness. As emotional arousal increases, the overall capacity of attentional processes is reduced because some of that capacity is then allocated to the monitoring or processing of arousal. This leaves less attentional capacity available for the performance of the cognitive task.

Hasher and Zacks (1979) have made similar arguments. They have written extensively on attentional capacity and different types of cognitive tasks. Their model is based on two assumptions. They propose a continuum of attentional requirements among cognitive processes, with automatic processes at one end and effortful processes at the other. Automatic processes are those that drain minimal energy from attentional capacity. Examples of automatic processes include analysis of frequency of occurrence, temporal sequence, and spatial location. Effortful processes require greater energy from attentional capacity. Examples of effortful processes include imagery, rehearsal, organization, and mnemonic techniques. In addition, they propose that attentional capacity is both finite and variable between individuals and within an individual across time. One of the factors that affects attentional capacity is emotional arousal, which has the effect of reducing available resources for cognitive work. Based on these assumptions, Hasher and Zacks proposed two hypotheses concerning attentional capacity and information processing. First, high levels of arousal will impair performance on tasks that make demands on attentional capacity (i.e., effortful processes). Secondly, automatic processes are not affected by arousal. This model has been the focus of much research and debate. Eysenck

(1982) has argued that the first hypothesis is generally supported by available research, in that high arousal has been shown to impair performance on tasks which make demands on attentional capacity. The second hypothesis, that high arousal has no effect on automatic processes, has received, at best, limited empirical support (Eysenck, 1982).

Easterbrook (1959) argued that high arousal results in a restriction of the number of cues an individual will use to learn and recall information: "Tasks requiring the use of greater numbers of cues were disrupted, while tasks requiring the use of smaller numbers of cues were facilitated by drive increment" (p. 192). Easterbrook reviewed a large literature of human and animal studies on drive (roughly synonymous here with the term arousal). The tasks employed in these experiments included attentional tasks, immediate and short term memory, and perceptual and motor tasks. He concluded that increased drive generally has the effect of reducing the range of cue utilization.

In a more recent discussion of the literature on arousal and performance, Eysenck (1982) attempted to integrate seemingly incompatible findings on the effects of arousal by proposing a two-part arousal system. One sub-system has a relatively passive effect on performance. This sub-system seems to follow a Yerkes-Dodson (1908) sort of function, with high and low levels of arousal leading to poorer performance in comparison with moderate levels of arousal. As performance falls because of high arousal or a lack of arousal, there is a greater likelihood that the second sub-system will intervene. This second component operates in an active fashion to compensate when the subject perceives that his/her performance has fallen below a desired level. As a result, extra resources and attention are redirected to the task at hand. This intervention has a cost, however. The highly aroused subject exerts significant effort to promote performance at the expense of "spare" processing capacity. There will be a resulting diminished ability to handle additional demands such as may be presented by a concurrent task.

Reason (1984) also discussed the impact of emotional arousal on executive processing. He described a vast array of schema, which are selectively activated or suppressed by a mobile attentional resource unit. An increase in arousal in this model would have the effect of increasing "fixedness" or reducing the adaptive mobility of the attentional resource unit. This fixedness would be manifest by "the 'routinization' in the performance of mental and physical activities . . . . a diminution in the flexibility of information processing" (p. 129).

The question of individual differences in arousal has been an important one in the literature on cognitive psychology. A model which has stimulated a great deal of interest and research activity was contributed by H. J. Eysenck (1967). He offered that persons differ along a continuum of psychophysiological arousal, with extraverts at one pole and introverts at the other. Although there are several versions of this theory (Eysenck, 1977), it is typically suggested that extraverts have a lower level of optimal arousal, whereas introverts are higher in arousal level. Research has often supported the findings that extraverts, compared with introverts, learn difficult tasks more quickly, recall verbal material better at short term intervals and more poorly at longer intervals, and show more efficient retrieval from episodic and semantic memory (Eysenck, 1977). However, the literature is not consistent in providing support for a trait model of arousal in which performance is based on one's standing on this single dimension of psychophysiological arousal. In an effort to go beyond a purely trait approach, some research has examined the interaction between the nature of the task and an individual's current level of arousal. For example, the concept of "state" anxiety (Spielberger, Gorsuch, and Luschene, 1969), independent of a more enduring trait model, allows greater flexibility in making predictions about cognitive processing and possible interactions of arousal with specific task demands. Much of the current research, however, continues to reflect an older concept of arousal as a trait concept. This leads to difficulty in integrating the concept of arousal into current methodologies looking at process-oriented aspects of information processing.

It is not possible to make broad, inclusive statements about the effects of arousal on memory. Instead, it is necessary to qualify such conclusions. Under what conditions does arousal influence which memory processes? Based on information from a wide variety of sources, it is possible to make a few tentative statements. It seems that the effect of greater arousal within a free recall task is to promote rote, ordered recall based on the physical characteristics of the material. When greater complexity of encoding is adopted as a strategy or is required to encode the material, one sees a corresponding drop in recall as a function of elevated arousal. This relationship may be mediated to some degree by individual differences, although too few studies have looked at interactions of task and arousal beyond a one-dimensional trait approach. Individual differences in choice of encoding strategy in Redeiss' (1986) study mediated the relationship between arousal and recall. Within the von Restorff literature, which is most directly related to the design of the present study, the effect of arousal is consistently detrimental. Words presented just prior to and just after an arousing event are recalled more poorly than words presented in the absence of an arousing event.

The more specific question is: what does high arousal disrupt? Differences in memory functioning based on strategies used and type of material presented suggest that arousal may specifically affect particular strategic processes, most notably encoding. One encoding process that has received considerable research and clinical attention is imagery.

The present study is concerned with the effects of arousal and imagery on recall where imagery can be conceptualized in two distinct ways. The next section will therefore provide a brief review of the imagery literature so that the question of a possible relationship between imagery and arousal can be explored.

Section 3. Imagery

The term "imagery effect" is often used in the cognitive psychology literature. It is employed variously to describe the imageability of some item of information, the facility with which that item is processed via particular encoding strategies, and information processing strategies that involve the individual's perception of the creation of a mental picture or image. The following discussion will examine the different facets of the "imagery effect."

The most general research finding about imagery is that highly imageable material is recalled better than poorly imageable material. The most enduring explanation of this phenomenon was provided by Paivio, a leading theoretician in the imagery field who has contributed influential conceptual and experimental work (Paivio, 1971; Paivio, 1986). His primary contribution has been the dual code theory. He describes two separate but interconnected subsystems which handle two different classes of cognitive phenomena. The imagery subsystem is specialized for the representation and processing of nonverbal objects and events. The verbal system is specialized for dealing with language. The two systems are functionally independent, but interconnected such that either can be activated in isolation, but each is also capable of initiating activity in the other. One implication of this theory is that high imagery material has the potential and greater likelihood of being encoded separately in the two different systems, whereas low imagery material is more likely to be encoded only in the verbal system. High imagery material, stored in two different forms, has a relatively greater likelihood of being retrieved than low imagery material, because there are two different forms of the stimulus which may be accessed.

An alternative explanation for the imagery effect is found in the work of both Marschark and Surian (1989) and Eysenck (1977). Marschark and Surian suggest that long term memory is both amodal and conceptual and that any dual code is a temporary phenomenon that serves to process information for storage into the conceptual code. They refer to a concreteness effect, rather than an imagery effect. According to Marschark and Surian, any advantage that concrete words have over abstract words is a function of both item-specific and relational processing. Relational processing, or the association of individual elements, serves to delineate the search set at the time of retrieval. Item-specific processing serves to increase the distinctiveness of individual items within that search set. This model is particularly well suited to the paired-associate literature in which it has largely been evaluated. Relational processing reduces the search process to the smaller universe of words presented in the task. Item-specific processing increases the likelihood of the generation of the appropriate response term from within that set. Imagery has the dual effect of providing a relational link between words and increasing the distinctiveness of particular words within a set. In this model, context can serve to elicit already encoded relationships in semantic memory, and/or relationships resulting from the particular encoding process at presentation. Concrete words are believed to have a greater number of potential contexts, providing for more elaborate relational processing in semantic memory and, thus, for a greater likelihood of retrieval from semantic memory.

Eysenck (1977) worked along the same theoretical lines. He also suggested that the role of Paivio's dual codes may be to process input for a central conceptual system which is amodal in nature. He reviewed the literature regarding the effects of different instructional sets on the imagery effect. Interactive imagery, similar to the relational processing of Marschark and Surian, involves imagery that links different stimuli together in a meaningful relationship. He hypothesized that the advantage of interactive or linking imagery over separation imagery is that it induces subjects to process more of the available conceptual features of stimuli.

Several experimental studies have looked at relational or interactive imaginal processing. Bower and Winzenz (1970) demonstrated that in a paired associate task, the imagery effect was dependent on instructional set, such that it was necessary to provide instructions to form images that integrated stimulus and response terms in order to obtain an imagery effect. Using a paradigm more closely related to the current study, Morris and Stevens (1974) performed a series of experiments in which they manipulated the instructional set given to subjects. They found that directing subjects to perform "linking imagery," or imagery in which the words were associated meaningfully with one another, resulted in much better recall of word lists than instructions to either image each word individually or to read the words out loud. In fact, there was not a significant difference in recall between these last two groups. This was demonstrated both as a between groups effect and as a within subject effect. Thus, the use of relational imagery in neutral or nonarousal conditions produces better recall than separation imagery or rote rehearsal. The guiding theory behind research into relational imagery and memory is that the organization of items affects recall. Relational imagery theoretically allows a person to recall fewer "chunks," although these chunks are larger than under separation imagery or rote rehearsal conditions (Begg, 1983).

As noted earlier, there has been substantial confusion as to what the "imagery effect" connotes. Because this has some direct bearing on the present study, some of the current controversies in the definition of imagery will be discussed. Specifically addressed topics will include the concreteness-imagery distinction and the stimulus-processing distinction.

Imagery is highly confounded with another factor seen frequently in the literature, concreteness. While these are obviously overlapping variables, they are not synonymous. Paivio (1968) used a factor analytic technique to demonstrate that rated imagery is superior to rated concreteness as a predictor of free recall. The most general findings are that easily imageable words are recalled better than poorly imageable words and that concrete words are recalled better than abstract words (Paivio, 1971). There is an increasing tendency to conceptualize concreteness as an attribute inherent in the internal semantic representation of a stimulus, yet which is highly correlated with the "imageability" of the stimulus material. This distinction has been evaluated primarily by varying the rated concreteness and imagery value of stimulus materials while simultaneously changing the encoding instructions given to subjects. According to Eysenck (1977), "Increasing emphasis is being placed on a distinction between concreteness as a fundamental semantic feature of the word, and imagery, defined as an encoding strategy applied to incoming material" (p. 49). He cites research in which concreteness is conceptualized as a stimulus dimension, distinct from imagery. Eysenck does not rule out the possibility that imagery may operate to some extent as a stimulus feature, but clearly emphasizes the importance of the operation or process of imagery.

Assessment of individual differences in imagery ability dates back to Galton's (1883) method of asking an individual to picture one's breakfast table, followed by a series of questions to examine the brightness, specificity, and coloring of the image. Modern day attempts to look at individual differences in imagery have typically followed the same path, emphasizing the individual's self-report of imaginal processing. Scales have been developed to examine the individual's report of frequency or habitual use of imagery (Paivio and Harshman, 1983), the vividness of one's mental imagery (e.g., definition, colorfulness, etc.) (Betts, 1909; Sheehan, 1967), and one's ability to perform tasks of spatial manipulation (Bennett, Seashore, and Wesman, 1963). Investigators have typically used one of these tasks as a measure of the individual's overall "imagery ability," failing to consider the potentially multifaceted nature of one's ability to create and utilize images in the performance of mental work. For this reason, it is not surprising that such self-report scales have correlated inconsistently with subjects' performance on imagery tasks (Eysenck, 1977). One criticism of using self-report tests of mental imagery is that the product of the verbal system is used to describe products of the visual sub-system, potentially confounding the distinction between Paivio's two coding systems (Eysenck, 1977). In fact, verbal report tests of imagery ability have been shown to correlate highly with measures of social desirability (Crowne and Marlowe, 1964). At this time, the assessment of individual differences in imaginal processing has not proven to be a major contribution to the field, although investigators continue to seek new ways to tap this seemingly important area. One very recent attempt to conceptualize individual differences in imagery stems from a neuropsychological approach (Kosslyn, Van Kleek, and Kirby, 1990) and may yet provide the research support sought by imagery researchers.

What is the imagery effect? In many studies, imagery is manipulated via altering the imageability of the materials to be learned and remembered. Within this context, we know that high imagery material is recalled better than low imagery material. Fewer researchers have looked at the process of mental imagery. The findings have often, but not consistently, demonstrated that persons using imagery have had better recall than persons not using imagery (Yarmey and Barker, 1971; Begg, 1983; Morris and Stevens, 1974). These results have been produced only under non-arousal conditions. In the next section, the possible relationship between arousal and imagery will be discussed.

<u>Section 4. The Relationship Between Arousal and Imagery</u>

The current study is concerned with the relationship between arousal and imagery. Little controlled research has been done in this area. A major theoretical contribution comes from Paivio's (1986) speculations on the relationship between imagery and arousal. He relegates all non-verbal processes, specifically including emotional arousal, to the functioning of the imagery system. He does allow that arousal can be elicited via the verbal system, but he states that this relationship is less direct than the arousal-imagery system. He cited specific research that links emotion and imagery with right hemisphere functioning (Bryden and Ley, 1983) but fails to predict what the specific effects of emotional arousal on imagery might be.

Paivio's tentative speculations were not supported by Butter (1970) who utilized a reminiscence paradigm. This particular study used paired associate lists, half of which placed concrete/high imagery words in the stimulus word positions, while the other half of the lists had abstract/low imagery words in those positions. In testing the relationship between imagery and measured physiological arousal, he found that low imagery words were associated with greater arousal as assessed by GSR (galvanic skin response) than were high imagery words. Unfortunately, his design did not allow a test of the interaction of arousal and imagery with regards to retention.

One indirect contribution to the research on imagery and arousal was the von Restorff study by Redeiss (1986), previously described. She looked indirectly at the interaction of imagery and arousal using a post-experimental question. Subjects were given examples of complex and simple strategies, and reported which of the two types they used. One example of a complex strategy was imagery.

She found that simple rote memory processes were significantly less vulnerable to the negative effects of arousal than were more complex strategies. Specifically, subjects using complex strategies showed impaired recall for words both preceding and following the CE, while subjects who used simpler strategies had impaired recall only for words that followed the CE. It is important to note that the role of imaginal processing per se was not determined, but only of complex strategies, one of which was imagery.

Another study (Voicu and Vranceanu, 1975) examined learning of lists and pictures under conditions of noise or quiet. Subjects were screened in advance and identified as being high or low in arousal. Thus, arousal served both as a subject variable and as an experimentally manipulated condition. Under conditions of high arousal (aroused subjects under noise conditions) recall of pictures, but not words, was impaired. Thus, recall of high imagery material was impaired by subjects' arousal, while recall of low imagery material was not.

The relationship between arousal and imagery has been more actively pursued by the clinical community. Systematic desensitization, hypnosis, and imagery in the treatment of cancer are examples of successful applications of imagery. Most relevant to the current topic is the use of imagery in treating anxiety disorders. Systematic desensitization, used to treat phobias, was first employed by Salter (1949) and popularized by Wolpe (1958, 1969). This technique is based on a classical conditioning paradigm and reflects the belief that if a "response inhibitory of arousal can be made to occur in the presence of anxiety-provoking stimuli, it will weaken the bond between the stimulus and anxiety" (Wolpe, p. 14).

Hanley and Chinn (1989) combined models of emotional arousal and imagery to discuss clinical applications in the area of stress management. They speculated that an advantage of using imagery to manage arousal-based disorders is that the patient's generation of images draws cognitive resources away from the distressing stimuli or images, and towards the self-generated image.

There are some difficulties in making predictions about the relationship between imagery and arousal based on existing clinical work. First, the hypothesized relationship between imaginal processing and arousal is not clearly defined or consistent. Some claim that imagery generates a sense of emotional and physical relaxation and that it serves to distract the patient from a current source of arousal (Hanley and Chinn, 1989), while others report that the beneficial effects of imagery are based on its potential to elicit levels of emotional arousal that the patient nonetheless finds to be tolerable (Vodde and Gilner, 1971). A second complicating factor is the typical combination of imagery-based therapeutic methods with the implicit or explicit goal of relaxation. Any singular action of imagery in terms of arousal is thus experimentally confounded.

To a certain degree, the use of imagery-based therapy in treatment of anxiety based disorders implies that imagery must attenuate the effects of arousal, or at least that the imagery not be disrupted by high arousal. If imaginal processing were significantly impaired by intense emotional arousal, then it is difficult to imagine how such methods could be employed successfully by phobic patients.

To summarize the clinical literature regarding imagery and arousal, two general and opposing approaches seem to prevail. Some clinicians claim that imagery promotes a state of relaxation incompatible with emotional arousal (Hanley and Chinn, 1989); other clinicians suggest the therapeutic benefit of imagery lies in its ability to elicit emotional arousal (Vodde and Gilner, 1971).

Imagery and arousal were experimentally manipulated in a recent study so that it was possible to examine the interaction of the two variables on recall (Parker, 1990). In this study, a von Restorff paradigm was employed to assess the effects of arousal on recall of lists of words presented auditorially to subjects. The CE in this situation was an extremely loud word. Subjects were presented with both high imagery and low imagery lists. In addition, subjects completed several individual difference measures in an attempt to isolate variables that might mediate the relationship between imagery and arousal with regard to recall. Specific measures examined state and trait anxiety, monitoring and blunting coping styles, and active behavioral coping, active cognitive coping, and avoidance coping styles. The results of this study indicated that high imagery words were more vulnerable to the effects of arousal than were low imagery words. In trying to understand the mechanism that might underlie these findings, an interaction of imagery, arousal, and self-reported active cognitive coping was examined. Subjects who rated themselves as high on a measure of active cognitive coping had impaired recall of high imagery words under conditions of arousal, but they had no disruption of recall of low imagery words. Arousal disrupted recall for subjects low on active cognitive coping without regard to the imageability of the material. Since both groups of subjects recalled high imagery lists better than low imagery lists, the interaction suggested that the two groups of subjects might differ in their method of processing the lists. Specifically, it was proposed that persons high in active cognitive coping were more likely than persons low in active cognitive coping to match processing strategy to task demands. They might be more likely to employ imagery selectively with highly imageable material, but to use rote strategies with poorly imageable material. It was suggested that certain individuals (those high in active cognitive coping) were more likely to employ more effortful, complex encoding strategies where appropriate, although these were then more vulnerable to the effects of arousal, according to a Hasher and

Zacks (1979) model of attentional capacity and information processing.

The previous study identified a relationship between imagery and arousal, but it was not designed to specify the mechanism of this interaction. That was the purpose of the present study. There is evidence that imagery, as a stimulus characteristic, interacts with arousal. Recall of high imagery material seems to suffer the effects of arousal to a greater degree than does recall of low imagery material. One may argue, however, that it is not the imageability of the material presented that affects recall, but the manner in which that material is processed. Thus we turn to studies and theoreticians that have alluded to the relationship between arousal and imaginal processing. In Redeiss' study, subjects using complex strategies, one of which was imagery, had greater disruption of memory than persons using simpler strategies. These results suggest that the more complex and effortful processing of imagery, and particularly relational imagery, would be more vulnerable to the effects of arousal than simpler strategies, such as rote rehearsal. This follows from the work of Hasher and Zacks (1979) and Redeiss (1986), among others.

Section 5. Rationale of Research Project

In the present study, the performance of subjects in a von Restorff auditory learning task using high and low imagery words was assessed. Subjects were presented with high imagery lists and low imagery lists under both neutral and arousal conditions. Subjects were randomly assigned to one of four encoding strategy groups. One group was directed to use relational imagery to link the words together. A second group was directed to image each word separately as it was presented. The third group was given rote rehearsal instructions. The fourth group was not instructed to use a particular encoding strategy, but the members of the group were instead told to use whatever process worked best for them. Each of the four instructional groups was composed of equal numbers of persons high and low on active cognitive coping, based on an initial screening and median split.

Parker (1990) marks the first use of the Health and Daily Living Form (HDL; Moos, Cronkite, Billings, and Finney, 1984) in a cognitive psychology experiment. The HDL has been used exclusively in the health psychology arena to explore factors which may influence treatment outcome, with specific indices pertaining to health-related and social functioning, life stressors, and social resources and coping strategies. The HDL has been found to be reliable and valid for use with emotionally disturbed and non-psychiatric populations (Shinke, 1989; Holahan and Moos, 1987; Billings and Moos, 1984; Holahan and Moos, 1985). The HDL was employed in the previous study as a measure of individual differences in coping strategies under conditions of stress. This was a speculative effort based on the assumption that the individual's cognitive and behavioral reactions under conditions of stress might be related to one's functioning on an information processing task under conditions of emotional arousal. The primary theoretical advantage of this measure lies in its emphasis on process, as opposed to trait, conceptualizations of human behavior. For this purpose, only the brief section specifically pertaining to coping strategies was used.

One design feature that differs from the previous study (Parker, 1990) relates to the arousal manipulation. In the earlier experiment, all subjects were instructed to produce the loud (CE) words first during the recall period, a manipulation referred to as high priority instructions. Saufley and Winograd (1970) and Redeiss (1986) both found that the von Restorff effect is enhanced by but is not dependent upon high priority instructions. High priority instructions were not used in the current study in order to rule out a possible bias in retrieval (Crowder, 1976; Smith, 1971) that might account for the previously observed relationships. Based on this design change, it was predicted that the arousal manipulation would be weaker but still present. Before presentation of the lists, subjects were alerted that some lists would contain loud words, but they were not given instructions to treat them in any unique way.

If the well-documented imagery effect is not due to the effects of processing strategy, then the results were expected to resemble those found in the previous study. That is, high imagery words would be recalled better than low imagery words, as in Paivio's dual code theory. Imagery and arousal would interact, such that recall of high imagery words would be disrupted to a greater extent by arousal than would recall of low imagery words. This would leave unanswered the question as to why words that are high in imagery are affected by arousal to a greater extent than low imagery words.

A different set of results was expected if the imagery effect is to some extent a function of processing strategy. In this event, encoding strategy would interact with the arousal and imagery variables in their effects on recall. Following from most theoretical interpretations of arousal effects, one would expect greater disruption of arousal for more complex, effortful processes such as relational imagery, and thus more disruption of recall. An alternate prediction, largely based on the speculations of some among the clinical community, is that imaginal processing may attenuate the detrimental effects of arousal on cognitive performance.

It is likely that the imagery effect is based on both a stimulus-bound feature and a processing strategy. Determining the impact of arousal on imagery as a stimulus feature and as an encoding strategy was the purpose of the current study.

METHOD

Overview

The primary focus of this study was to determine the effect of an arousing event on recall of words in a serial list. Word lists were composed of either high or low imagery words. Each list had 13 words, of which the central, or seventh, word was termed the "critical event." When a particular list was designated as an arousal list, this central word was amplified to 120 decibels (db). All other recorded words and instructions, as well as the central word in the non-arousal lists, were presented at a conversational volume, 75 db. All subjects were presented with 8 word lists, of which 4 were high imagery, 4 low imagery, 4 arousal, and 4 neutral, in a completely counterbalanced fashion. This resulted in 2 lists each of four types: high imagery arousal, high imagery neutral, low imagery arousal, and low imagery neutral.

The two between groups measures were encoding strategy and active cognitive coping. Subjects were randomly assigned to one of four encoding strategy groups: uninstructed, rote rehearsal, separation imagery, relational imagery. In addition, equal numbers of persons high and low on a scale of active cognitive coping were placed in each encoding group. This division was based on a median split performed on the active cognitive coping scores.

After the recall period for the last list presented, subjects were asked to identify the strategy they had used to encode the lists. They responded to a multiple choice question which allowed for description of any strategies not specifically described.

Subjects

The subjects were 96 University of Alabama at Birmingham undergraduate psychology students. These students earned class credits in exchange for their participation in this study. The subject pool contained 42 males and 54 females. In age, they ranged from 17 to 44 years, with a mean of 21.67. From 5 to 15 students signed up and participated at a time. Recruitment was done by means of a sign-up sheet in the psychology lobby. A block randomization procedure was used to assign subjects to conditions. Within each experimental group of twelve, three subjects were assigned to each of four conditions, based on the directions they were given for encoding the lists. The four groups were rote rehearsal, separation imagery, relational imagery, and uninstructed. Due to the high attrition rate associated with the recruitment process, it was impossible to fully balance every session with regards to the number of persons high and low on active cognitive coping or with regards to the numbers of persons assigned to the four encoding strategies. Additional groups were run to fill the missing cells of the design.

Design

The design of the experiment is a (2 X 2 X 6) X 2 X 4 mixed factorial. The variables were by imagery (high, low), by arousal (arousal, neutral), by serial position (six levels), by active cognitive coping (high, low), and by encoding strategy (uninstructed, rote memorization, separation imagery, and relational imagery). Active cognitive coping and encoding strategy were between group variables. Imagery, arousal, and position were within subjects variables. Position was redefined as a six level variable. Adjacent non-CE words were collapsed, creating a six level variable from a 12 level variable.

Apparatus

Lists of 13 words were professionally recorded on audiotape so that the critical word at position 7, in the arousal condition, could be amplified relative to the other words. All other words, as well as the position 7 words in the non-arousal lists, were presented at 75 db. In the arousal condition, the position 7 word was amplified to 120 db. All lists were checked for appropriate volume, clarity of verbal material, and any distortion or extraneous noise. Audiotapes were played on a JVC RC-X3 portable sound system.

Materials

Materials consisted of two pools of 52 words each selected from the Kucera and Francis (1987) word compilations. One pool of words included words high in imagery, and the other included words ranked as low in imagery, based on empirically derived ratings in the Kucera and Francis (1987) compilations. Words were chosen with the following restrictions: 1) all words were between 4 and 10 letters long; 2) all could be used as a noun; 3) words could not have obvious homophones; 4) words were selected so that lists were comparable in frequency of use, meaning, pleasantness, and familiarity. Resulting lists were checked to assure that assignment did not result in lists containing clusters of semantically related words or numerous words with the same letter. Four orders of each list were created by random assignment, such that no one word was presented in the same serial position more than once. The word lists used in this study were drawn from those used in the previous study (Parker, 1990). One order of each list was randomly assigned to one of four forms of test materials, each then containing four lists of high imagery words and four lists of low imagery words. Critical event (CE) lists were those that contained a loud word at serial position 7. Each of the four orders of each of the four word lists served as a CE list exactly once, and as a neutral, or control, list exactly once. In this way, eight different forms were constructed, containing four high imagery lists and four low imagery lists, half of which were CE lists and half of which were neutral or control lists. The four lists were randomly ordered within the forms. Each list began with the word "ready," followed after two seconds by the first word of that list. Words were presented at the rate of one word every two seconds. The different forms of the wordlists are provided as Appendix A.

Other materials used in the study included one part of the Health and Daily Living Form (HDL; Moos, Cronkite, Billings and Finney, 1984). A copy of the coping strategy component of the scale is provided as Appendix B. The HDL has been found to be reliable and valid in studies of both emotionally disturbed and non-psychiatric populations (Shinke, 1989; Holohan and Moos, 1987; Billings and Moos, 1984; Holohan and Moos, 1985). The portion of the HDL used in this study is the section that assesses different types of coping strategies. The three coping styles tapped by this instrument are active cognitive coping, active behavioral coping, and avoidance coping.

All subjects received one of four booklets, depending on the encoding strategy group to which they had been randomly assigned (Appendix C). On the first page of each booklet were instructions as to the method the subject was to use to encode the word lists. Persons in the uninstructed condition were told to remember as many words as they could, without specifying any particular method. In the rote memorization condition, subjects were instructed to remember the words by repeating them silently to themselves. In the separation imagery condition, subjects were instructed to remember the words by forming a mental image of each word individually as it was presented. In an example, they were told to remember "dog" by imagining a dog, to remember "car" by imagining a car. In the relational imagery condition, subjects were instructed to remember words by imagining them together in scenes: for example, given the words "boy," "tree," and "water," one could imagine a boy watering a tree.

Procedure

One experimenter, the author, ran all experimental sessions. At the beginning of a session, up to twelve subjects were brought to a classroom and seated approximately equidistant from a stereo. They were told that the experiment would involve the assessment of memory. They were given an informed consent form and asked to read it before signing (Appendix D). Subjects provided information as to gender and age, and completed a portion of the Health and Daily Living Form (HDL; Moos, Cronkite, Billings, and Finney, 1984). Following this, there was a 5 minute interval in which the active cognitive coping index was calculated and subjects were assigned to groups based on a median split. Subjects were provided with written instructions at this time, in which they were assigned a particular strategy to use. Audiotaped instructions were presented to all subjects (Appendix E). On this recording, subjects were told they would be asked to remember lists of words. In addition, it was stated that on some of the lists, a word would be presented at the intensity of a loud shout. Subjects were then instructed to ask the investigator quietly if they had any questions regarding the task, so that other subjects would not be exposed to the instructions for a different condition. During all of the testing sessions, however, not a single person asked for clarification.

The tape then began as described under Materials. Each form of the word lists was given simultaneously to members of the four encoding strategy groups and to persons both high and low on active cognitive coping. After presentation of a list, subjects were told to "Write down all the words you can remember" via audiotaped instructions. The recall period was 90 seconds long, after which the word "ready" preceded the first word of the next list by two seconds. Following the recall period for the final list, subjects identified the encoding strategy they used to remember the lists. This question was phrased in the form of a multiple choice item, giving examples of rote rehearsal, separation, and relational imagery. Subjects were permitted to endorse more than one choice of strategy, and to mark "other." In the latter case, they were prompted to briefly describe the strategy used. Booklets were then collected from the students. Finally, subjects were debriefed as to the purpose of the study, given the opportunity to ask questions, and were asked not to disclose to anyone details about the experiment (Appendix F). Students then received extra credit vouchers for their participation and were dismissed.

RESULTS

The results are presented here in four sections. In the first section, the primary analysis of the recall data is presented. In the second section, the data are examined with reference to the use of encoding strategy, first using the Chi Square and then by separating subjects' data by whether or not they reported using the assigned strategy. The third section includes the analysis of the recall data for the critical position within the word lists. Finally, in the fourth section, the data on only the uninstructed group are examined, with special attention to replication of the previous study.

Section 1. Primary Analysis of Recall Data

The initial analysis included all three of the primary within subjects variables (imagery, arousal, and position), the two between groups variables (encoding strategy and active cognitive coping), and the two demographic variables (sex and age). There were two levels of imagery (high, low), two levels of arousal (arousal, neutral), and six position levels. Each level of position actually represented four possible responses in the original data. Two lists were collapsed for each condition, and each of the non-critical event positions was analyzed in pairs. This resulted in six levels of position for each condition. The between groups variable encoding strategy had four levels (uninstructed, rote rehearsal, separation imagery, and relational imagery). The between groups variable active cognitive coping had two levels (high, low) based on a median split. None of the individual difference variables, active cognitive coping, sex, and age (as a covariate), demonstrated significant main or interactive effects. These variables were dropped from subsequent analyses.

The primary analysis, then, included imagery, arousal, position, and encoding strategy. The results of this analysis are shown in Table 1. The design is a four way mixed analysis of variance, (2 X 2 X 6) X 4. There was a significant main effect for imagery [$F(1,92) = 53.42$, $p < 0.0001$]. This reflects greater recall of high imagery words relative to low imagery words. Comparison of the arousal and neutral conditions resulted in a statistically significant main effect [$F(1,92) = 10.32$, $p < 0.005$]. Recall was poorer in general for material learned in association with arousal than it was for material learned under neutral or nonarousing conditions. There was a statistically significant main effect of position [$F(5, 460) = 143.06$, $p < 0.0001$]. A trend analysis performed on position indicated a quadratic trend [$F(1,95) = 720.81$, $p < 0.0001$]. This demonstrates that the first and last few items of a list were recalled much more often than the more central items. This recency and primacy effect is shown in Figure 1. The main effect of instructional set was not statistically significant [$F(3,92) = 0.91$, $p =$

0.4398]. This indicates that the assigned encoding strategy did not independently affect overall recall.

There was a statistically significant interaction between imagery and position [$F(5,460) = 7.42$, $p < 0.0001$] and between arousal and position [$F(5,460) = 5.77$, $p < 0.0001$]. In an effort to clarify these interactions, the data were analyzed with position reassigned as a two-level variable. All six words prior to the critical event were grouped together, as were all six words following the critical event. In this way, it was possible to examine the impact of imagery and arousal on verbal material before and after the critical event. There was a significant effect of imagery on words prior to the critical event [$F(1,95) = 66.43$, $p < 0.0001$]. This reflects better recall of words in high imagery lists relative to recall of words in low imagery lists, for words in the first half of the lists. The imagery value of words presented after the critical event did not significantly affect recall [$F(1,95) = 3.74$, $p < 0.0561$]. The interaction of imagery and position appears to represent a limited imagery effect, such that high imagery words are recalled better than low imagery words, but only for words presented in the first half of the lists. This relationship is shown in Figure 2.

The interaction of arousal and position was also analyzed using position as a two-level variable. The effect of arousal on words preceding the critical event was not statistically significant [$F(1,95) = 0.64$, $p <$

0.4257]. The effect of arousal on words following the critical event was statistically significant [$F(1,95) = 24.12$, $p < 0.0001$]. Overall, recall of words in arousal lists was poorer than recall of words in neutral lists; this effect, however, was restricted to the words that followed the critical event. Words that preceded the critical event were not significantly affected by arousal. The relationship of arousal and position is graphed in Figure 3.

There was a statistically significant interaction among imagery, arousal, and position. Performing the analysis with position assigned as a two level variable (before and after the CE) did not reveal the source of this interaction. Thus, the interaction of imagery and arousal at the six different levels of position was examined. There was a significant interaction of imagery and arousal only at Position 4, and not at any other position. Position 4 represented the two words that immediately followed the critical event. The results of this analysis (arousal x imagery at position) are as follows: Position 1 [$F(1,95) = 3.37$, $p < 0.0694$], Position 2 [$F(1,95) = 0.46$, $p < .5004$], Position 3 [$F(1,95) = 0.96$, $p < 0.3296$], Position 4 [$F(1,95) = 13.85$, $p < 0.0005$], Position 5 [$F(1,95) = 0.16$, $p < 0.6892$], Position 6 [$F(1,95) = 0.73$, $p < 0.3939$]. The interaction at Position 4 was then analyzed. This interaction reflected a detrimental effect of arousal on recall of high imagery words [$F(1,95) = 18.09$, $p < 0.0001$], which was not evident for recall of low imagery words [F(1,95) = 0.38, p < 0.5399]. Thus, arousal impaired recall of high imagery words, but not low imagery words, that immediately followed the arousing event. The interaction of imagery value and arousal is shown in Figure 4.

The most theoretically interesting of the interactions was a three-way interaction among arousal, position, and encoding strategy [F(15,460) = 1.80, p < 0.0323]. To understand this interaction, the two-way interactions of arousal and position were tested at each of the four levels of encoding strategy. These are shown in Figures 5, 6, 7, and 8. The analysis showed that for subjects who were instructed to use one of the imagery techniques, there was no interaction of arousal and position: separation imagery, F(5,115) = 2.19, p = .0602; relational imagery, F(5,115) = 1.71, p = .1387. At this point, an analysis of the simple main effects of arousal for these two groups demonstrated that arousal did not significantly impair recall for subjects assigned to use an imagery method: separation imagery, F(1,23) = 0.64, p = 0.4308; relational imagery, F(1,23) = 0.85, p = .3662. Thus, the interaction of arousal, position, and encoding strategy reflects an interaction of arousal and position for subjects who were either uninstructed [F(5,115), 2.37, p < .05] or directed to use rote rehearsal [F(5,115), 4.70, p < 0.001], where this interaction was not observed for the two imagery groups. In order to clarify the observed arousal and position interaction, the simple effects of arousal at each level of position were analyzed for the rote rehearsal and uninstructed groups. An initial analysis based on position as a two level variable did not specify the nature of the interaction. The data were then analyzed at each of the six levels of position. The results indicated a significant effect of arousal at Position 5 for both groups [uninstructed, $F(1,23) = 9.20$, $p < .01$; rote rehearsal, $F(1,23) = 34.31$, $p < 0.0001$], which was not present at any other position when the lists were collapsed across imagery. Thus, in this analysis, a detrimental effect of arousal on recall was limited to words at the fifth position in the non-imagery conditions.

It appears that the simple effect of arousal at the fifth position for the uninstructed and rote rehearsal groups is responsible for the overall main effect of arousal. While this appears to be a highly localized effect, several factors may be of interest in understanding these results. First, each level of position in this design actually reflects two words in the original memory task. Secondly, the fourth position, or the two words immediately following the critical event, are in fact affected by arousal in the form of an interaction of imagery and arousal, as noted above. This is a very robust effect which reduces the likelihood that one will isolate any simple effects of arousal at this position. Finally, the recency effect noted at the last position is likely to obscure any arousal effect which might otherwise be seen at this position. In other words, because these items are held in auditory short term memory with relatively little elaborative processing, the potentially disruptive effects of arousal are less likely to impair recall of these items.

Section 2. Analysis of Recall Data with Reference to Use of Assigned Strategy

Shown in Table 2 is the distribution of subjects with reference to the assigned encoding strategy and the strategy that they endorsed using. Self-reported encoding strategy was assessed in the form of a multiple choice question at the end of the last recall period. Subjects were allowed to endorse more than one strategy in describing their use of encoding methods. Table 3 details the Chi square tests performed on the data for subjects assigned a particular strategy. The subjects in the uninstructed group were dropped from this analysis, which was intended to demonstrate the level of agreement between one's assigned strategy and reported use of that strategy. Because subjects could endorse more than one choice on the multiple choice question, separate Chi Square tests were performed on each multiple choice option in order to not violate the independence assumption of this statistical test. Furthermore, subjects in a given group were compared with members of the remaining two instructed groups in their endorsement of a particular strategy. For example, Table 3 shows that 75% of the persons in the rote rehearsal group reported using rote rehearsal, while only 48% of the persons in separation and relational imagery groups reported use of rehearsal, a difference which was statistically significant [Chi Square (1) = 4.787, $p < 0.05$]. None of the other Chi Square tests attained statistical significance. Based on these tests, the level of agreement between one's assigned strategy and the reported use of that strategy is somewhat disappointing.

Further analysis was performed on the data in order to clarify the role of instructional set in the findings. In one supplementary analysis, subjects who reported that they did not use the assigned strategy were excluded from the analysis (Group A). This analysis, then, was performed on subjects who reported using an assigned strategy as well as on those who were not assigned a particular strategy. In a second analysis, subjects who reported that they did use the assigned strategy were excluded (Group B). This analysis was performed on those who reported that they did not use the assigned strategy and on those subjects who were not assigned a specific strategy. The results of these analyses are shown in Tables 4 and 5. The main and interactive effects for the two subgroups are consistent with the overall analysis, with the exception of three interactions that were present for Group A but absent in the analysis on Group B. The interaction of imagery, arousal, and position was present for members of Group A but absent for members of Group B. The interaction of arousal, position, and encoding strategy was also found among subjects in Group A but not in Group B members. It appears likely from these data that persons who used the assigned strategy account for the more complex interactions observed in the larger data set.

One interaction was identified for members of Group A which was not present in the overall analysis. This was an interaction of imagery and arousal found for subjects in Group A [$F(1,61) = 4.91$, $p < 0.05$], but not for the subjects of Group B [$F(1,51) = 0.24$, $p < 0.6249$]. This last interaction reflected a detrimental effect of arousal on recall of high imagery words [$F(1,64) = 11.62$, $p < 0.01$] but not low imagery words [$F(1,64) = 0.09$, $p = .7613$], as shown in Figure 9.

Another set of supplementary analysis was performed to clarify the role of encoding strategy. This addressed the overall relationship of self-reported strategy to recall independently of assigned strategy. To clarify the role of self-reported strategy, three separate analyses of variance were performed as in the original analysis, substituting self-reported strategy for assigned strategy. Since subjects were allowed to endorse more than one self-reported strategy, three independent analyses of variance were calculated. The results of these tests are presented in Tables 6, 7 and 8. Two findings are particularly relevant to the present question. Subjects who reported that they did not use rote rehearsal had better overall recall than subjects who reported that they did use rote rehearsal [$F(1,94) = 5.22$, $p < 0.05$]. Persons who reported using relational imagery had better overall recall [$F(1,94) = 4.35$, $p < 0.05$] when compared with persons who reported that they did not use relational imagery. These findings are consistent with previous research that indicates that rote rehearsal is generally a less effective encoding strategy than more complex strategies, including relational imagery. With regard to the present study, these analyses indicate that the choice of strategy does impact on information processing, and that this choice of strategy is poorly related to the strategy that is assigned.

Section 3. Analysis of Recall Data for Critical Event

A separate analysis was performed on the critical event items. For items in Position 7 in the original data set, there was a significant effect of imagery [$F(1,95) = 6.07$, $p < 0.0156$]. This reflects better recall of high imagery words than low imagery words. The effect of arousal was significant [$F(1,95) = 130.58$, $p < 0.0001$], such that amplified words were recalled much more often than words in the central position that were not amplified. The interaction of imagery and arousal did not attain statistical significance.

Section 4. Analysis of Recall Data for Uninstructed Group

A final analysis was performed only on the data of the uninstructed group, as this group provided a systematic replication of an earlier study. The results of this analysis are shown in Table 9. The active cognitive coping variable produced no main or interactive effects and was subsequently dropped from the analysis. There was a main effect of imagery [$F(1,23) = 7.62$, $p < 0.05$], such that high imagery words were recalled better than low imagery words. There was also an effect of position [$F(5,115) = 37.67$, $p < 0.0001$]. Trend analysis performed on these data indicates a significant quadratic trend [$F(1,23) = 221.09$, $p < 0.0001$], consistent with the recency and primacy effect in the recall data. The main effect of arousal approached but did not attain statistical significance [$F(1,23) = 3.20$, $p < 0.0869$]. There was, however, a significant interaction of imagery and arousal [$F(1,23) = 5.08$, $p < 0.05$]. As shown in Figure 10, this is the result of a detrimental effect of arousal on recall of high imagery words [$F(1,23) = 9.00$, $p < 0.01$] which was not present for recall of low imagery words [$F(1,23) = 0.00$, $p < .949$]. The interaction of arousal and position was statistically significant [$F(5,115) = 2.37$, $p < 0.05$]. Analysis indicated that arousal had a detrimental effect on recall of words presented after [$F(1,23) = 6.50$, $p < 0.0179$], but not before [$F(1,23) = 0.14$, $p < 0.7129$], the critical event. The two way interaction of imagery and position [$F(5,115) = 1.13$, $p < 0.3468$] did not attain statistical significance.

DISCUSSION

The primary goal of this study was to examine the singular and interactive effects of emotional arousal, imagery, and encoding strategy on memory performance. A more specific purpose was to determine whether the imagery effect is attributable to characteristics of the material to be learned (imagery value) or to the process applied to that material (encoding strategy). To the extent that the imagery effect reflects an automatic advantage of easily imageable material over poorly imageable material, one would expect that highly imageable material would be remembered better than poorly imageable material, irrespective of encoding strategy employed in encoding the word lists. This is most consistent with the type of formulation put forth by Paivio (1971) in his dual code model. The alternate explanation is that imageable material is remembered better because imageable material invites more effortful, richly detailed processing, causing it to be more accessible at retrieval. Such process oriented theoreticians as Hasher and Zacks (1979), Eysenck (1977), and Marschark and Surian (1989) have emphasized the importance of imaginal processing in explaining the imagery effect. In addition, they have described relative virtues of relational, or integrative, imagery over separation imagery. For them, the imagery value of material is still an effect to account for, but the stronger effect lies in the processing strategy applied to that material.

Consistency with Previous Literature

This study largely replicated previous research in the areas of imagery and arousal, including a previous study by this investigator. High imagery words were recalled better than low imagery words, and arousal had the general effect of disrupting recall. A strong recency and primacy effect was found among the recall data. Both imagery and arousal interacted with position within the list. The advantage of high imagery words was strongest in the first half of the word lists, possibly reflecting a tendency to hold the most recent information in auditory memory. The arousal effect was strongest in the second half of the word lists. This was consistent with previous research using the von Restorff paradigm, in which the strongest effect of arousal was found in serial positions succeeding, rather than preceding, the arousing event (Redeiss, 1986). This pattern is seemingly in contrast with the investigator's previous study (Parker, 1990), in which the arousal effect was evident for all positions following the arousing word as well as for the position immediately preceding it. This apparent discrepancy can probably be attributed to a methodological difference between the two experiments, in that high priority instructions for recall of the critical event were not used in this study but were employed for the earlier experiment. As Redeiss (1986) demonstrated, high priority instructions tend to make the arousal effect stronger and increase the likelihood that prior verbal material will also be affected as well as that material which follows the arousing event.

Active cognitive coping, found previously to interact significantly with imagery and arousal, produced no independent or interactive effects in this study. While it is possible that this simply represents a spurious result in the previous experiment, there are two alternate explanations. First, the present study was not a direct replication of the previous study. As described above, the arousal manipulation was weaker in magnitude as a result of the absence of high priority instructions. This individual difference variable may only have an effect at higher levels of arousal. That is to say, persons high and low in active cognitive coping may behave similarly at low or moderate levels of arousal. An active cognitive coping style may only affect information processing at intense levels of arousal. A second possible explanation for the absence of an effect of active cognitive coping lies in the encoding strategy manipulation. Active cognitive coping was conceptualized as a tendency to match specific cognitive processes to particular tasks when under duress. To the extent that assigning strategy removed some degree of choice, the role of active cognitive coping may have been attenuated. Given this, members of the uninstructed group may have been expected to show an effect of coping strategy. However, based on the magnitude of the effect in the previous study, a larger sample size may be required in order to isolate any significant effects of active cognitive coping. In the current study, only 24 persons were assigned to the uninstructed group.

Challenges Associated With Telling People How To Think

A major difficulty in interpreting these data stems from the low rate of agreement between the assigned encoding strategy and the strategy or strategies that subjects reported using. Assigned strategy exerted no main or interactive effects on recall in the primary analysis. By contrast, it was found that self-reported use of strategy was related to recall. Persons who reported using rote rehearsal remembered fewer words than persons who reported not using rote rehearsal. Persons who reported using relational imagery recalled more than persons who indicated that they did not use relational imagery. Statistical analysis showed that subjects were only slightly more likely to use a strategy when it was assigned than when it was not. In fact, a large percentage of subjects reported using a combination of strategies (34%). This may be an important lesson for cognitive psychology. It is extremely difficult to make people think in a way that they do not want to or are not able to think. Yet despite this difficulty, when looking at the divided data based on agreement between assigned and self-reported strategy, it was clear that the more complex interactions were based on the responses of persons who indeed did use the assigned technique. The lesson here is that encoding strategy may play a part in these complex interactions of arousal and imagery but that altering another's thought process is a difficult manipulation to achieve.

<u>What Is the "Imagery Effect?"</u>

Based on these findings, the imagery effect reflects both a characteristic of material to be encoded and an effect of encoding strategy. Some more specific conclusions can be drawn. First, the imageability of verbal material provides a potent and robust effect. This stimulus-bound imagery effect is disrupted by emotional arousal. When persons are not given instructions with regard to strategy or when they report using an assigned strategy, their recall of highly imageable material is disrupted to a much greater extent than is recall of poorly imageable material. Thus, while highly imageable material is recalled better under neutral (non-arousal) conditions than poorly imageable material, it is much more vulnerable to the disruptive effects of arousal for these subjects. One possible explanation of this stimulus-bound effect may come from the work of Butter (1970). If low imagery words are associated with greater levels of arousal, this may explain the advantage of high imagery words under non-arousal conditions. Under conditions of arousal, this advantage may be lost, causing a greater relative impairment of recall of high imagery words relative to low imagery words. Among subjects who reported that they did not use the assigned strategy, this interaction of imagery and arousal was not found. The nature of the relationship among imagery, arousal and compliance with strategy instructions is not clear.

The effect of processing strategy is statistically weaker, within the context of this experimental design. One reason for this, clearly, is the previously mentioned difficulty in gaining compliance in encoding strategy. With this qualification noted, we can draw a few conclusions concerning the interaction of encoding strategy with imagery and arousal. For subjects who were uninstructed or assigned a rote rehearsal condition, recall of words following the critical event was impaired by arousal. This effect was not found for subjects in the separation imagery and relational imagery conditions. Analysis demonstrated a more global relationship between arousal and encoding strategy. The recall of subjects in the two groups instructed to use imagery was unaffected by the arousal manipulation, whereas recall in the rote rehearsal group was significantly impaired by arousal.

There appear to be two distinct imagery effects. One has been well-documented; that is, high imagery words are recalled better than low imagery words. This effect is robust and is easily replicated under a variety of experimental conditions. The imagery effect as a stimulus feature is easily disrupted by emotional arousal; that is, the advantage of high imagery words is significantly reduced by an arousing event. The second imagery effect is manifest in the encoding strategy that is applied to verbal material. Use of imagery as an information-processing strategy appears to protect the memory process from the otherwise detrimental effects of arousal. This effect was somewhat tenuous and difficult to produce experimentally. Nonetheless, the "encoding strategy" imagery effect does appear to insulate information processing from the effects of arousal. This will not come as a surprise to the many clinicians who use imagery-based techniques in the treatment of a wide range of anxiety disorders.

Given that there are two imagery effects, their relationships with emotional arousal appear to be diametrically opposed. These results are inconsistent with an effortful-automatic processing distinction, such as that made by Hasher and Zacks (1979). Imaginal processing might well exert a protective influence on cognitive processing as opposed to making it more vulnerable to the effects of arousal. In the present study, there was certainly no evidence that imagery is a process especially vulnerable to the detrimental effects of arousal.

The results of the current study suggests several possibilities for future research. Examination of more successful manipulations of imaginal processing would be of interest. It may be advantageous to screen subjects on habitual use of imagery and to include this as a subject variable. Alternately, the encoding strategy manipulation might be strengthened by extensive training in use of particular strategies prior to the experimental manipulation. Contrasting the arousal manipulation, using groups that do or do not receive high priority instructions may get at effects that are limited to only the higher levels of emotional arousal. For example, active cognitive coping may only be a useful individual difference variable at higher levels of arousal. Having subjects respond via both recall and recognition could isolate the effects in terms of cognitive process: disruption of encoding, consolidation, or retrieval. This would be particularly useful in trying to understand how it is that imaginal techniques insulate information processing from the disruptive effects of arousal.

Table 1

ANOVA Table of Primary Analysis: Imagery by Arousal by Position by Instructional Set

Source	df	SS	MS	F
Instructional Set	3	7.536	2.512	0.91
Subj (Instructional Set)	92	253.672	2.757	
Imagery	1	53.473	53.473	53.42**
Imag x Inst	3	3.723	1.241	1.24
Subj (Imagery)	92	92.095	1.001	
Arousal	1	8.146	8.146	10.32*
Arous x Inst	3	1.543	0.514	0.65
Subj (Arousal)	92	72.602	0.789	
Position	5	965.294	193.059	143.06**
Posit x Inst	15	27.743	1.850	1.53
Subj (Position)	460	620.755	1.350	
Imag x Arous	1	2.066	2.066	3.13
Imag x Arous x Inst	3	1.616	0.539	0.82
Subj (Imagery x Arousal)	92	60.776	0.661	
Imag x Posit	5	33.915	6.783	7.42*
Imag x Posit x Inst	15	20.628	1.375	1.50
Subj (Imagery x Position)	460	420.415	0.914	
Arous x Posit	5	24.377	4.875	5.77*
Arous x Posit x Inst	15	22.798	1.520	1.80*
Subj (Arousal x Position)	460	388.783	0.845	
Imag x Arous x Posit	5	15.884	3.177	2.76*
Imag x Arous x Posit x Inst	15	17.715	1.181	1.03
Subj (Imag x Arous x Posit)	460	529.193	1.150	

Note: The following abbreviations are used in this table:

Imag = Imagery
Arous = Arousal
Posit = Position
Inst = Instructional Set

* $p < .05$ ** $p < .01$

Table 2

<u>Comparison of Assigned Strategy to Self-Reported Encoding Strategy for all Groups.</u>

	Assigned Strategy			
	Rote Rehearsal	Separation Imagery	Relational Imagery	Uninst
Self-reported Strategy				
Rote Rehearsal	18	13	10	12
Separation Imagery	9	12	7	6
Relational Imagery	8	6	11	12
Other	4	4	2	3

<u>Note: The following abbreviation is used in this table:</u>

Uninst = Uninstructed

Table 3

<u>Chi square: Comparison of Subjects Assigned to Rote Rehearsal Condition versus Separation Imagery and Relational Imagery Conditions, on Self-Reported Encoding Strategy Use</u>

	Instructional Group		
	Rote Rehearsal	Separation Imagery Relational Imagery	Chi sq
Self-reported Strategy			
Rote Rehearsal	75%	47%	4.787*
Separation Imagery	37%	40%	0.029
Relational Imagery	33%	35%	0.031
Other	17%	12%	0.232

* $p < 0.05$

Table 3 cont.

Chi square: Comparison of Subjects Assigned to Separation Imagery Condition versus Rote Rehearsal and Relational Imagery Conditions, on Self-Reported Encoding Strategy Use

	Instructional Group		
12%	Separation Imagery	Rote Rehearsal Relational Imagery	Chi sq
Self-reported Strategy			
Rote Rehearsal	54%	58%	0.113
Separation Imagery	50%	33%	1.870
Relational Imagery	25%	39%	1.501
Other	17%	12%	0.232

* $p < 0.05$

Table 3 cont.

Chi square: Comparison of Subjects Assigned to Relational Imagery Condition versus Rote Rehearsal and Separation Imagery Conditions, on Self-Reported Encoding Strategy Use

	Instructional Group		
12%	Relational Imagery	Rote Rehearsal Separation Imagery	Chi sq
Self-reported Strategy			
Rote Rehearsal	42%	65%	3.427
Separation Imagery	29%	44%	1.432
Relational Imagery	46%	29%	1.961
Other	8%	17%	0.929

* $p < 0.05$

Table 4

ANOVA Table for Group A: Data Set Excluding Subjects Who Did Not Use Assigned Strategy

Source	df	SS	MS	F
Instructional Set	3	4.432	1.477	0.53
Subj (Inst)	61	170.395	2.793	
Imagery	1	45.472	45.472	39.44**
Imag x Inst	3	3.407	1.136	0.99
Subj (Imag)	61	70.332	1.153	
Arousal	1	3.463	3.463	4.59*
Arous x Inst	3	3.755	1.252	1.66
Subj (Arous)	61	46.131	0.755	
Position	5	690.447	138.089	107.76**
Posit x Inst	15	25.476	1.700	1.33
Subj (Posit)	305	390.851	1.28	
Imag x Arous	1	3.052	3.052	4.91*
Imag x Arous x Inst	3	1.823	0.608	0.98
Subj (Imag x Arous)	61	37.917	0.622	
Imag x Posit	5	26.030	5.206	5.72**
Imag x Posit x Inst	15	17.348	1.156	1.27
Subj (Imag x Posit)	305	277.774	0.911	
Arous x Posit	5	17.170	3.434	3.96*
Arous x Posit x Inst	15	22.690	1.513	1.75*
Subj (Arous x Posit)	305	264.233	0.866	
Imag x Arous x Posit	5	16.212	3.242	2.84*
Imag x Arous x Posit x Inst	15	10.210	0.681	0.60
Subj (Imag x Arous x Posit)	305	348.096	1.141	

Note: The following abbreviations are used in this table:

Imag = Imagery
Arous = Arousal
Posit = Position
Inst = Instructional set

* $p < .05$ ** $p < .01$

Table 5

ANOVA Table for Group B: Data Set Excluding Subjects Who Used Assigned Strategy

Source	df	SS	MS	F
Instructional Set	3	7.897	2.632	0.76
Subj (Inst)	51	177.121	3.473	
Imagery	1	14.274	14.274	12.61**
Imag x Inst	3	2.075	0.692	0.61
Subj (Imag)	51	57.709	1.131	
Arousal	1	5.806	5.806	7.06*
Arous x Inst	3	2.340	0.780	0.95
Subj (Arous)	51	41.951	0.823	
Position	5	365.152	73.030	52.36**
Posit x Inst	15	15.972	1.065	0.76
Subj (Posit)	255	355.691	1.395	
Imag x Arous	1	0.159	0.159	0.24
Imag x Arous x Inst	3	3.589	1.196	1.82
Subj (Imag x Arous)	51	33.499	0.657	
Imag x Posit	5	15.278	3.056	3.23**
Imag x Posit x Inst	15	20.546	1.370	1.45
Subj (Imag x Posit)	255	241.042	0.945	
Arous x Posit	5	19.961	3.992	5.17**
Arous x Posit x Inst	15	11.979	0.799	1.03
Subj (Arous x Posit)	255	196.957	0.772	
Imag x Arous x Posit	5	4.529	0.906	0.84
Imag x Arous x Posit x Inst	15	27.146	1.810	1.69
Subj (Imag x Arous x Posit)	255	273.503	1.072	

Note: The following abbreviations are used in this table:

Imag = Imagery
Arous = Arousal
Posit = Position
Inst = Instructional Set

* $p < .05$ ** $p < .01$

Table 6

ANOVA Table, Self-Reported Use of Rote Rehearsal by Imagery Value by Arousal by Position

Source	df	SS	MS	F
Use of Rote	1	13.731	13.731	5.22*
Error (Rote)	94	247.477	2.632	
Imagery	1	54.027	54.027	53.31**
Imag x Rote	1	0.555	0.555	0.55
Subj (Imag)	94	95.264	1.013	
Arousal	1	7.706	7.706	9.82**
Arous x Rote	1	0.362	0.362	0.46
Subj (Arous)	94	73.783	0.785	
Position	5	945.995	189.199	138.34**
Posit x Rote	5	5.710	1.142	0.83
Subj (Posit)	470	642.788	1.368	
Imag x Arous	1	2.095	2.095	3.16
Imag x Arous x Rote	1	0.029	0.029	0.04
Subj (Imag x Arous)	94	62.363	0.663	
Imag x Posit	5	36.230	7.246	7.86**
Imag x Posit x Rote	5	8.015	1.603	1.74
Subj (Imag x Posit)	470	433.028	0.921	
Arous x Posit	5	24.626	4.925	5.69**
Arous x Posit x Rote	5	4.594	0.919	1.06
Subj (Arous x Posit)	470	406.987	0.866	
Imag x Arous x Posit	5	14.041	2.808	2.45**
Imag x Arous x Posit x Rote	5	8.940	1.788	1.56
Subj (Imag x Arous x Posit)	470	537.968	1.145	

Note: The following abbreviations are used in this table:

Imag = Imagery
Arous = Arousal
Posit = Position
Rote = Self-reported use of rote rehearsal

* $p < .05$ ** $p < .01$

Table 7

ANOVA Table, Self-Reported Use of Separation Imagery by Imagery Value by Arousal by Position

Source	df	SS	MS	F
Use of Separation Imagery	1	2.648	2.648	0.96
Subj (SI)	94	258.560	2.751	
Imagery	1	50.120	50.120	49.21**
Imag x SI	1	0.085	0.085	0.08
Subj (Imag)	94	95.734	1.018	
Arousal	1	6.675	6.675	8.49**
Arous x SI	1	0.252	0.252	0.32
Subj (Arous)	94	73.893	0.786	
Position	5	890.251	178.050	131.09**
Posit x SI	5	10.154	2.031	1.50
Subj (Posit)	470	638.344	1.358	
Imag x Arous	1	1.910	1.910	2.88
Imag x Arous x SI	1	0.000	0.000	0.00
Subj (Imag x Arous)	94	62.391	0.664	
Imag x Posit	5	31.595	6.319	6.81**
Imag x Posit x SI	5	4.671	0.934	1.01
Subj (Imag x Posit)	470	436.372	0.928	
Arous x Posit	5	28.045	5.609	6.60**
Arous x Posit x SI	5	12.323	2.465	2.90*
Subj (Arous x Posit)	470	399.258	0.849	
Imag x Arous x Posit	5	18.605	3.721	3.22**
Imag x Arous x Posit x SI	5	4.535	0.907	0.79
Subj (Imag x Arous x Posit)	470	542.372	1.154	

Note: The following abbreviations are used in this table:

Imag = Imagery
Arous = Arousal
Posit = Position
SI = Self-reported use of separation imagery

* $p < .05$ **$p < .01$

Table 8

ANOVA table, Self-Reported Use of Relational Imagery by Imagery Value by Arousal by Position

Source	df	SS	MS	F
Use of Relational Imagery	1	11.547	11.547	4.35*
Subj (RI)	94	249.660	2.656	
Imagery	1	54.175	54.175	53.78**
Imag x RI	1	1.120	1.120	1.11
Subj (Imag)	94	94.699	1.007	
Arousal	1	7.036	7.036	8.96**
Arous x RI	1	0.300	0.300	0.38
Subj (Arous)	94	73.845	0.786	
Position	5	915.896	183.179	135.33**
Posit x RI	5	12.330	2.466	1.82
Subj (Posit)	470	636.167	1.353	
Imag x Arous	1	2.590	2.590	3.95*
Imag x Arous x RI	1	0.840	0.840	1.28
Subj (Imag x Arous)	94	61.552	0.655	
Imag x Posit	5	33.171	6.634	7.20**
Imag x Posit x RI	5	8.216	1.643	1.78
Subj (Imag x Posit)	470	432.827	0.921	
Arous x Posit	5	23.643	4.729	5.43**
Arous x Posit x RI	5	2.306	0.461	0.53
Subj (Arous x Posit)	470	409.275	0.870	
Imag x Arous x Posit	5	11.280	2.256	2.00
Imag x Arous x Posit x RI	5	16.748	3.350	2.97*
Subj (Imag x Arous x Posit)	470	530.159	1.128	

Note: The following abbreviations are used in this table:

Imag = Imagery
Arous = Arousal
Posit = Position
RI = Relational Imagery

*$p < .05$ **$p < .01$

Table 9

ANOVA Table for Uninstructed Subjects

Source	df	SS	MS	F
Imagery	1	12.840	12.804	7.62*
Subj (Imag)	23	38.743	1.684	
Arousal	1	2.778	2.778	3.20
Subj (Arous)	23	19.972	0.868	
Position	5	238.268	47.674	37.67**
Subj (Posit)	115	145.549	1.266	
Imag x Arous	1	3.063	3.063	5.08*
Subj (Imag x Arous)	23	13.854	0.602	
Imag*Posit	1	55.514	1.103	1.13
Subj (Imag x Posit)	115	111.903	0.973	
Arous x Posit	5	9.285	1.857	2.37*
Subj (Arous x Posit)	115	89.965	0.782	
Imag x Arous x Posit	5	13.042	2.608	2.63*
Subj (Imag x Arous x Posit)	115	114.042	0.992	

Note: The following abbreviations are used in this table:

Imag = Imagery
Arous = Arousal
Posit = Position

* $p<.05$ **$p<.01$

Figure 1. Mean words recalled by position

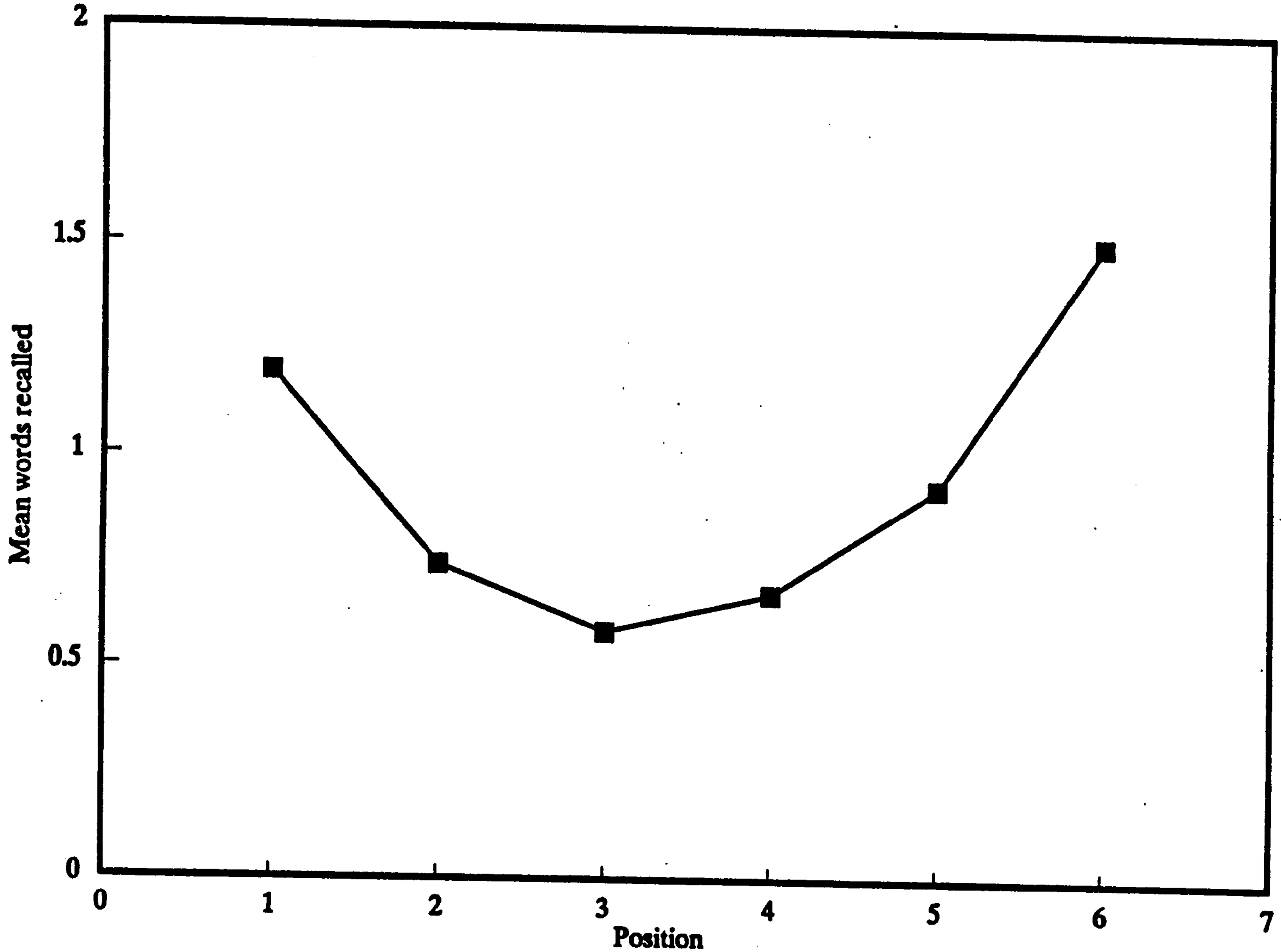


Figure 2. Mean words recalled as a function of imagery value, position defined as a two level variable

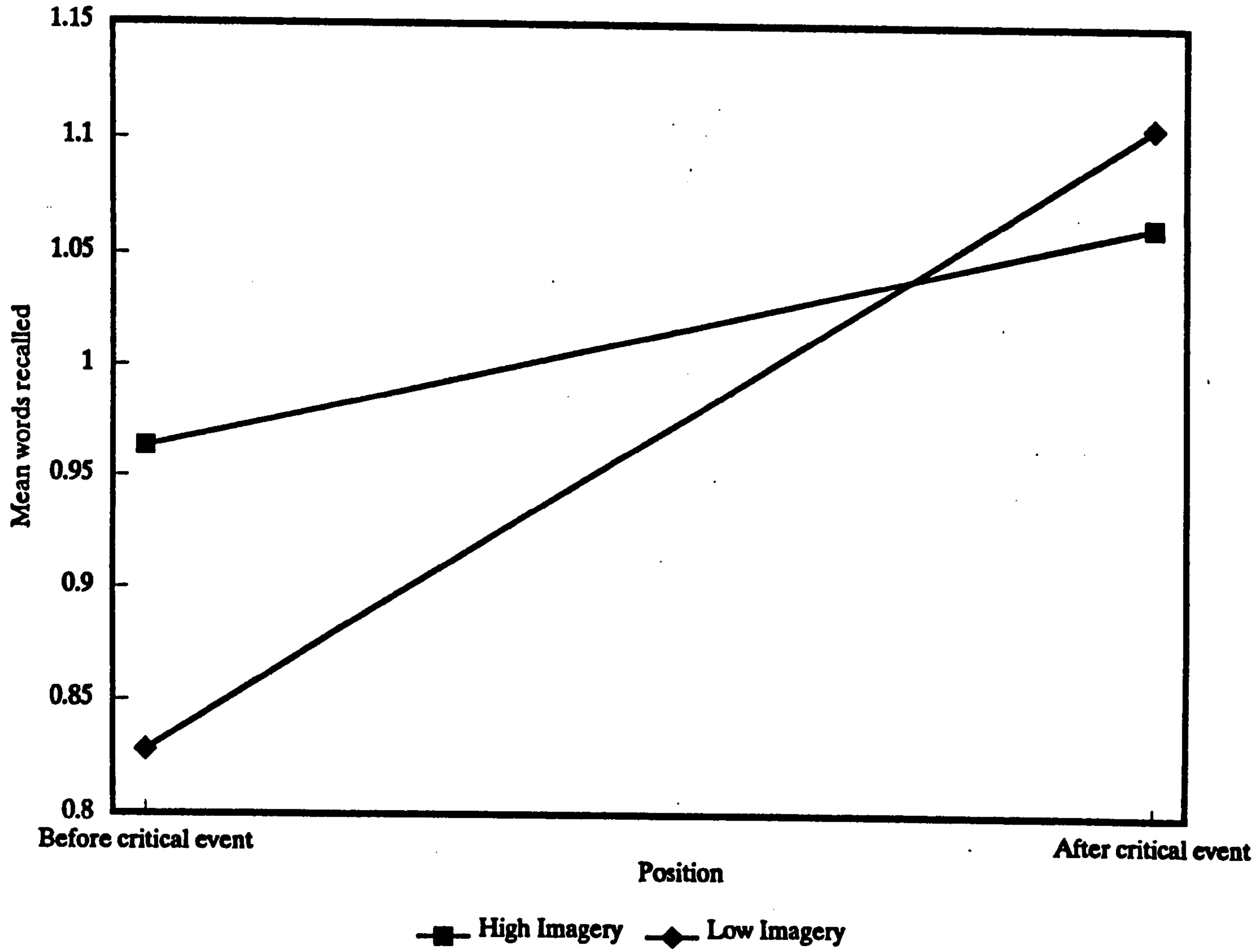


Figure 3. Mean words recalled as a function of arousal condition, position defined as a two level variable

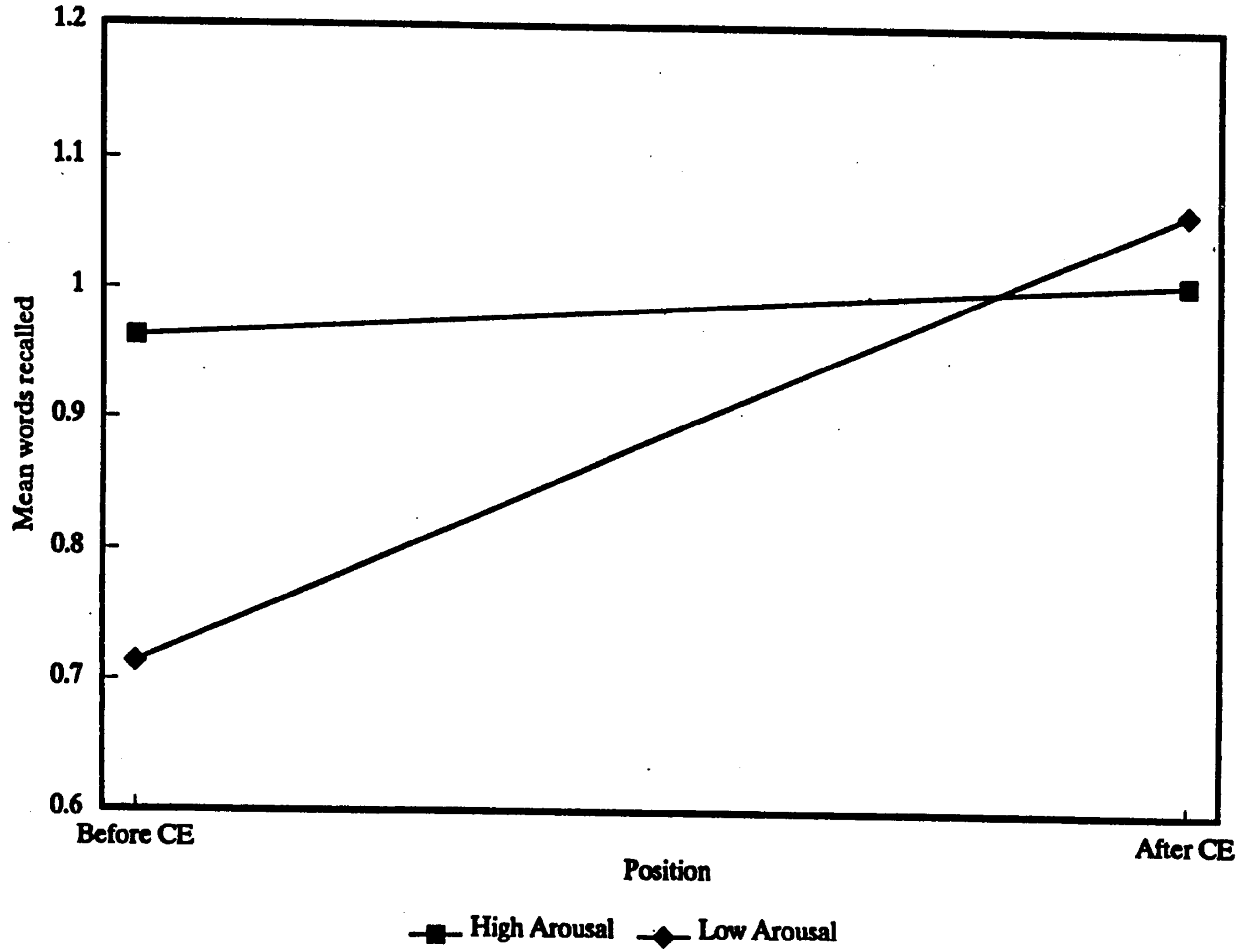


Figure 4. Mean words recalled at position 4 as a function of imagery value and arousal

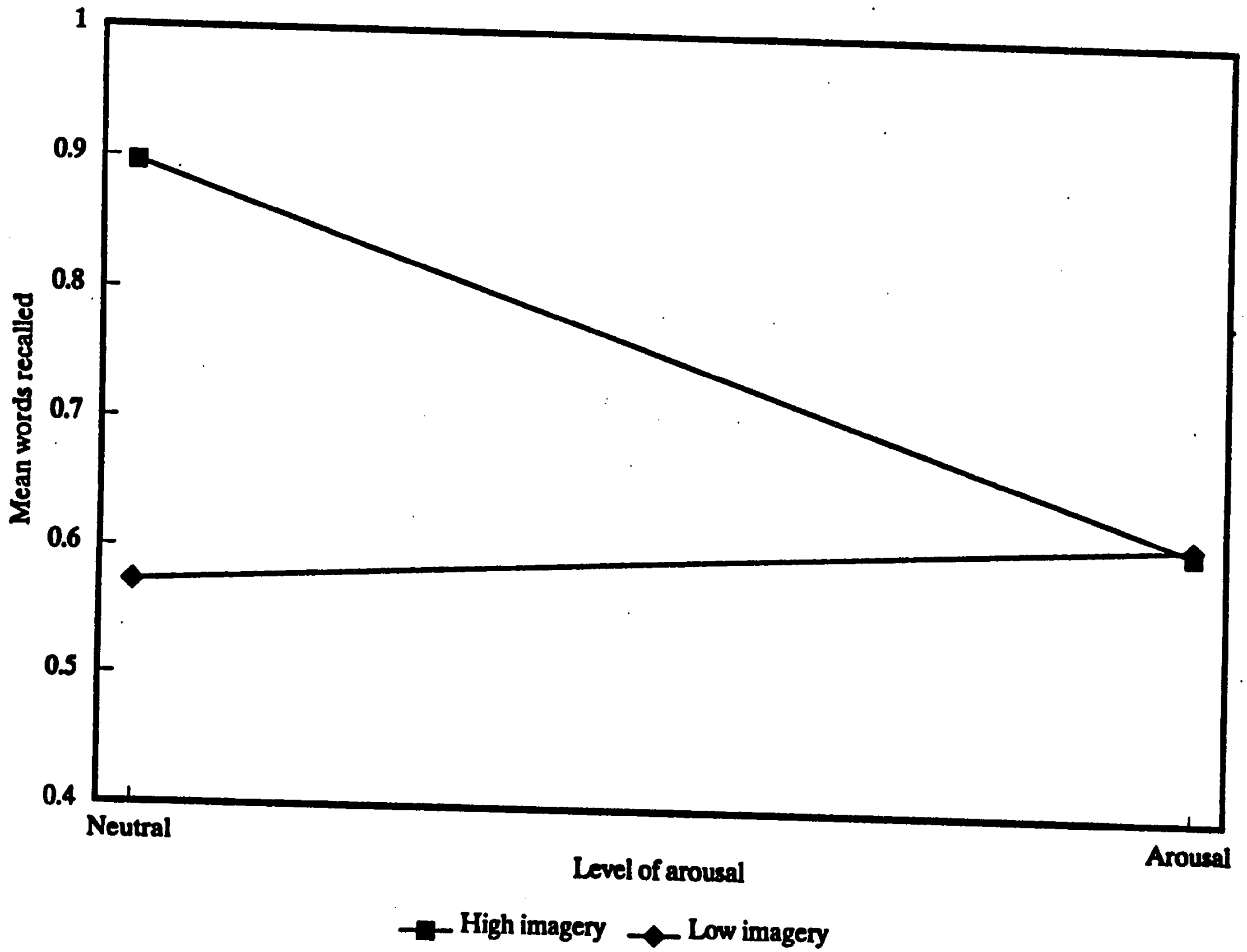


Figure 5. Mean words recalled by subjects in uninstructed condition as a function of arousal and position

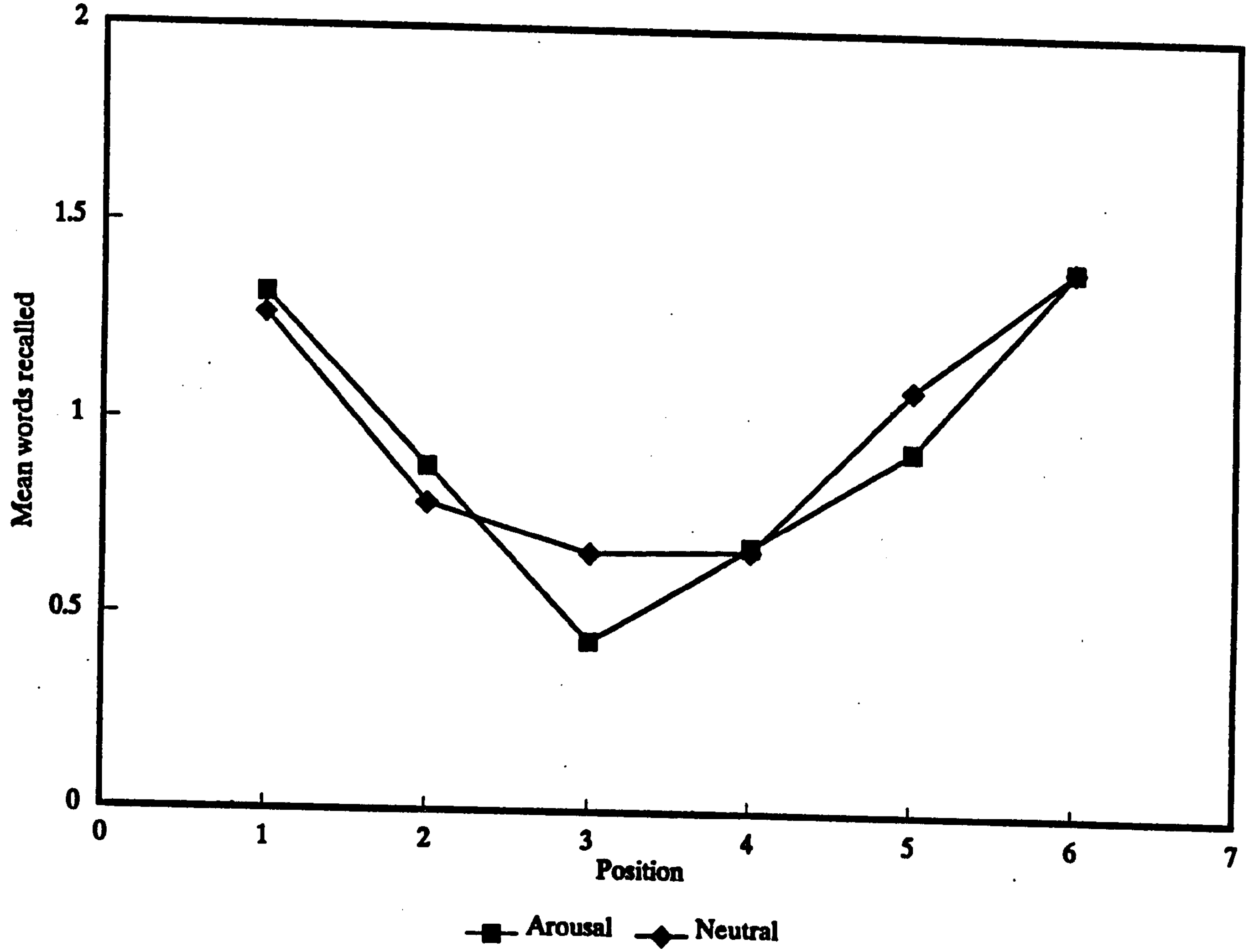


Figure 6. Mean words recalled by subjects in rote rehearsal condition as a function of arousal and position

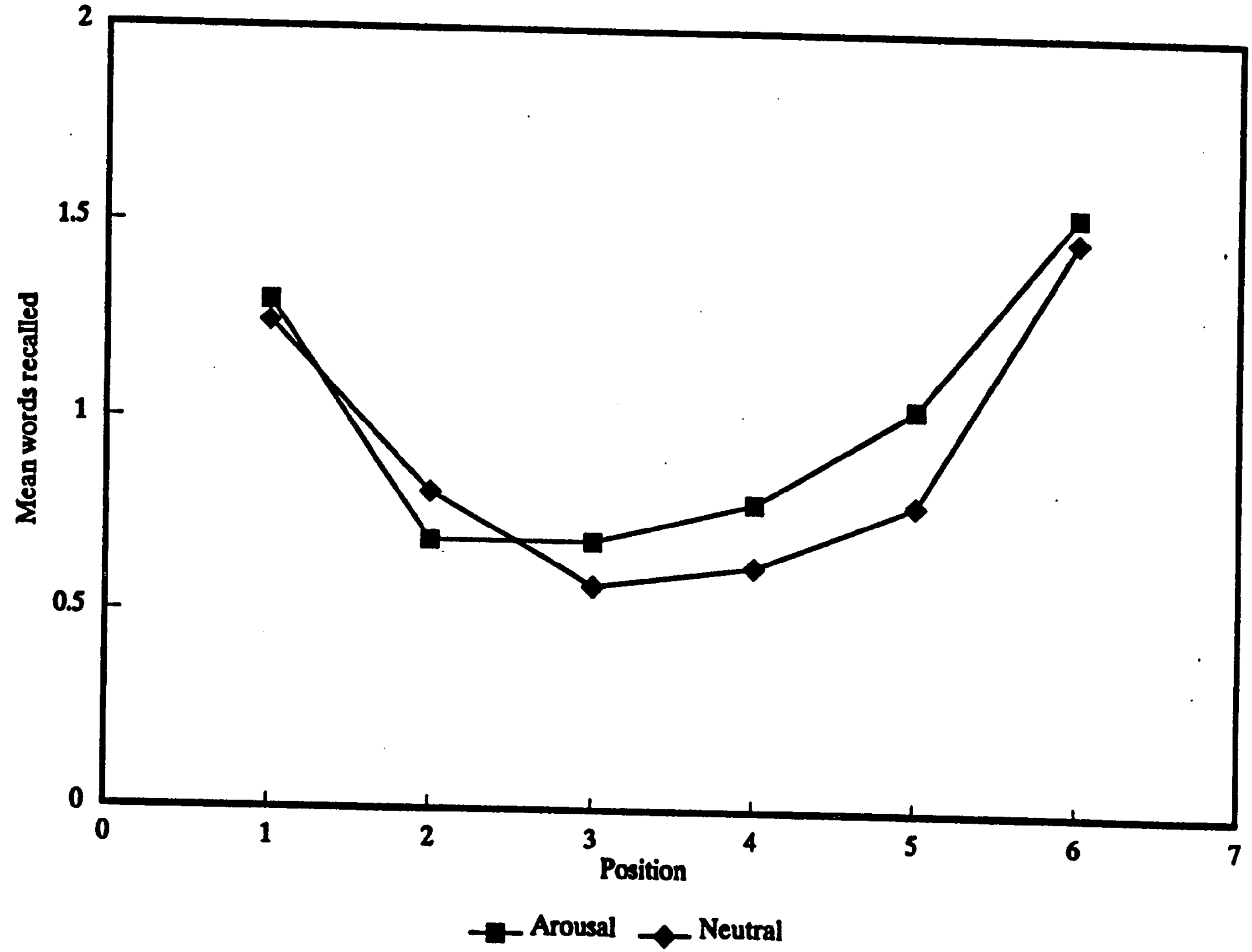


Figure 7. Mean words recalled by subjects in separation imagery condition as a function of arousal and position

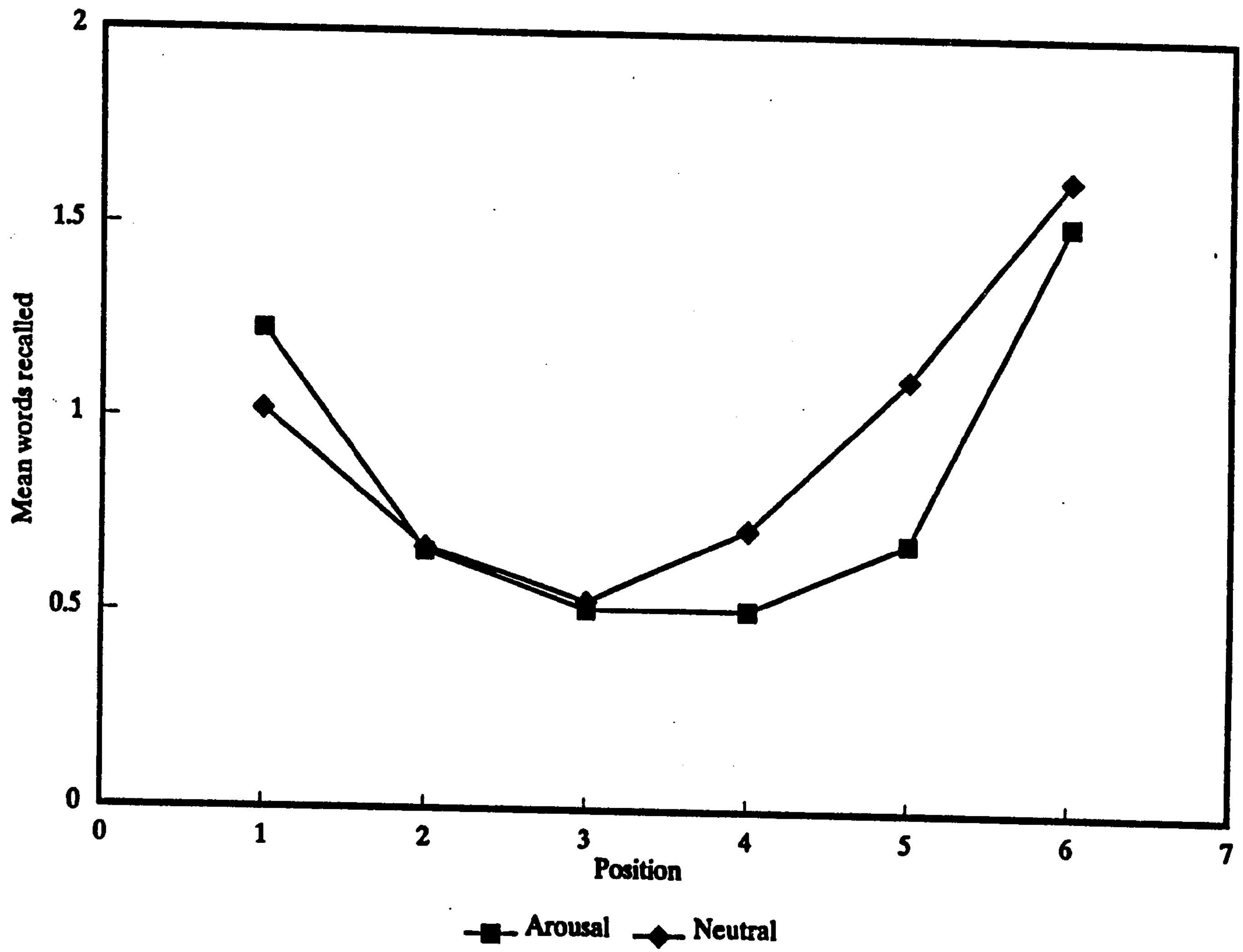


Figure 8. Mean words recalled by subjects in relational imagery condition as a function of arousal and position

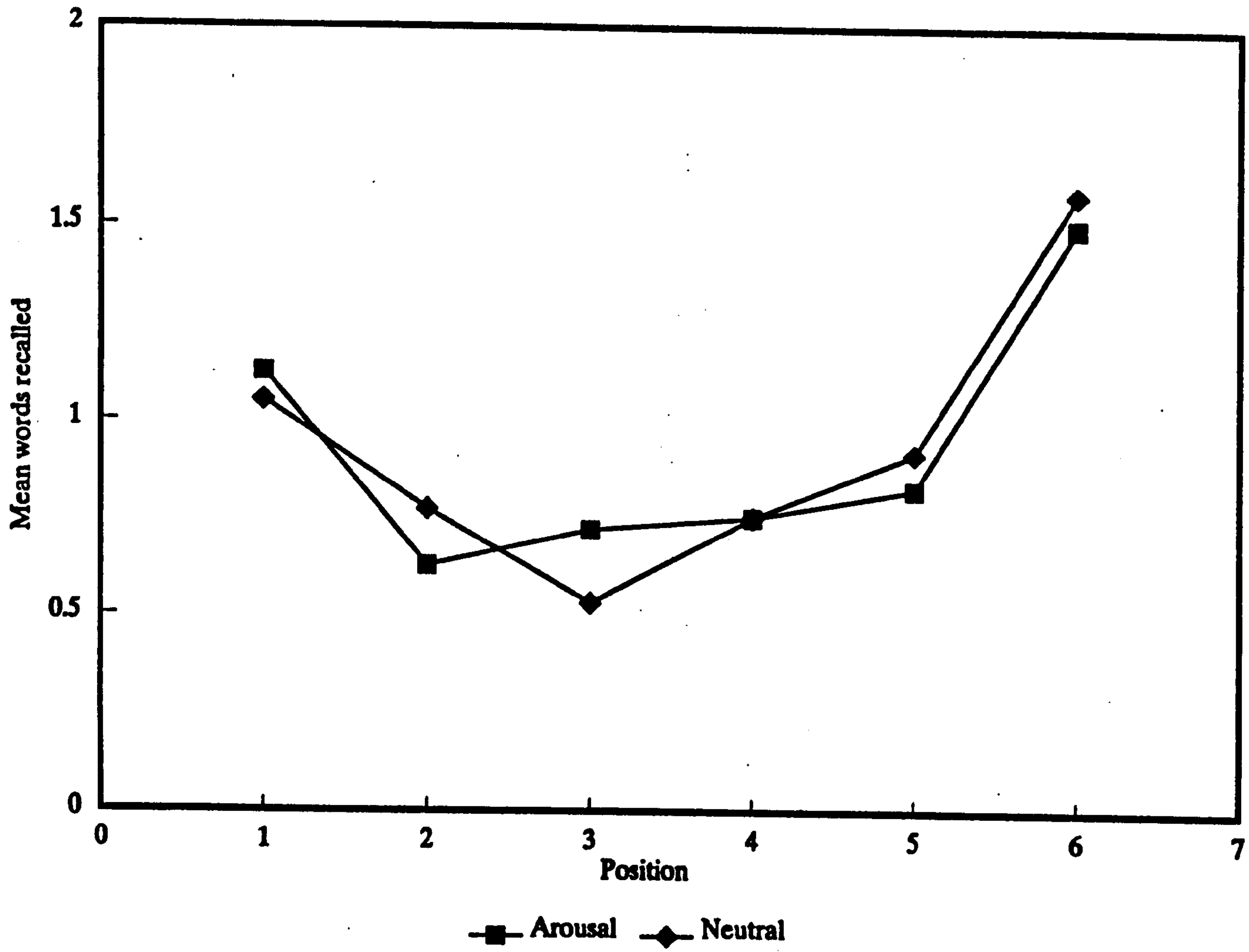


Figure 9. Mean words recalled by uninstructed subjects in group A, as a function of imagery and arousal

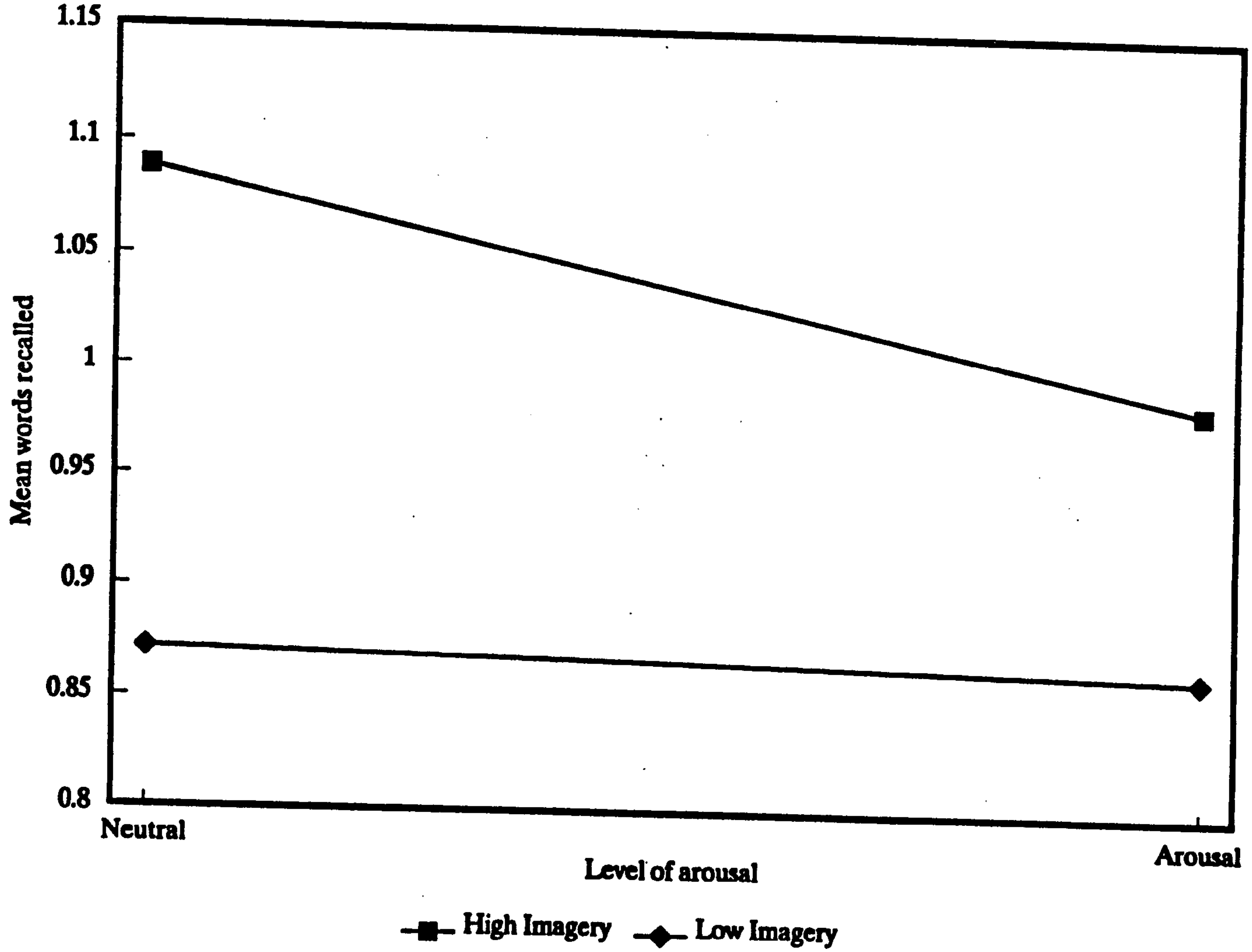
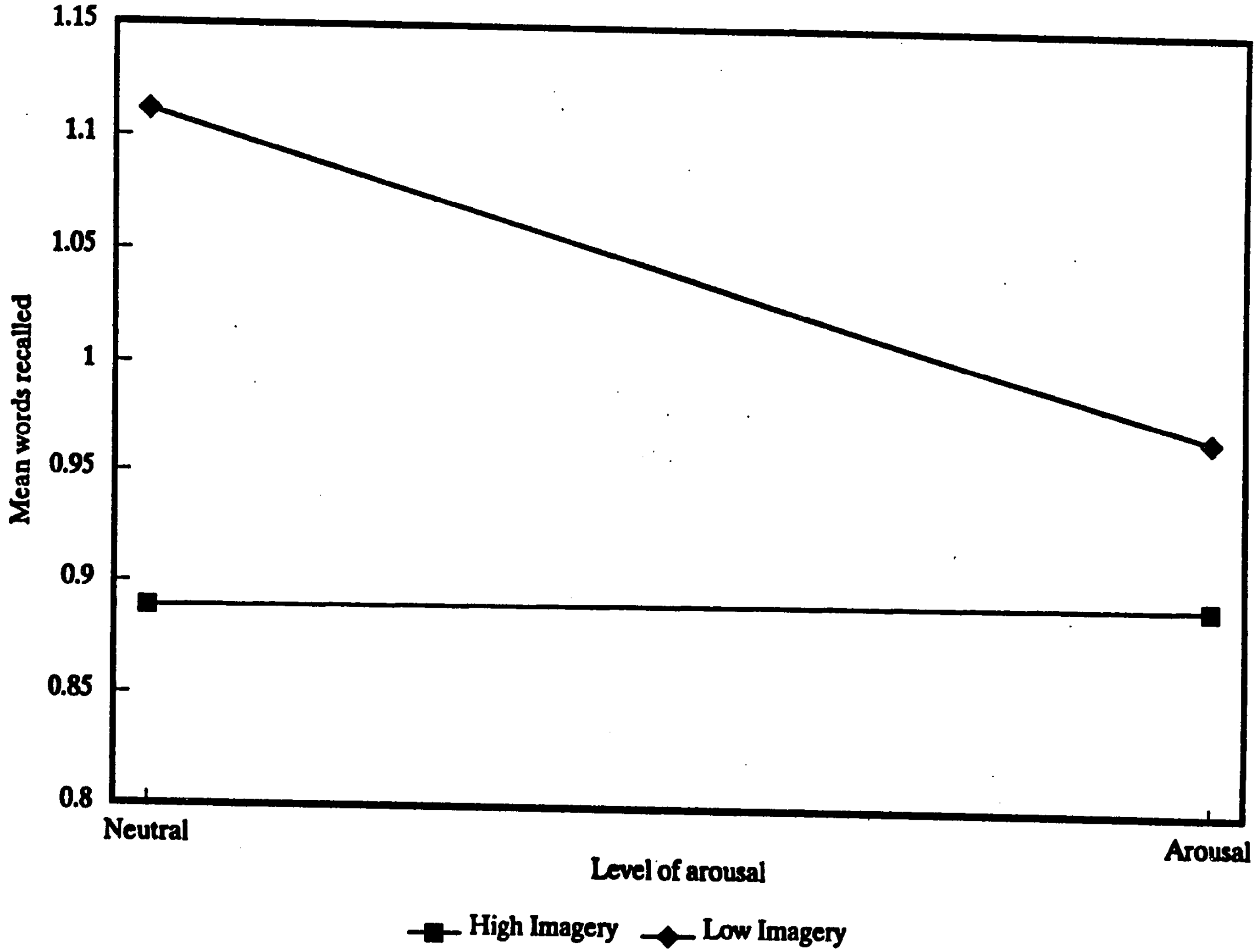


Figure 10. Mean words recalled by uninstructed subjects as a function of imagery and arousal



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APPENDIX A

WORD LISTS

Form 1

List 1	List 2	List 3	List 4
meeting	knowledge	club	worth
safety	item	insect	liberty
cure	grudge	ammonia	audition
accord	clue	telephone	fear
plea	guilt	web	pronoun
fact	phase	court	wisdom
lure	pardon	battle	account
trust	idea	jail	adverb
prefix	question	goat	belief
hazard	excuse	mermaid	duty
cause	grammar	bill	span
eternity	method	train	science
trouble	folly	gravel	plan

List 5	List 6	List 7	List 8
fate	miles	knife	car
debt	beggar	square	money
discord	propeller	dishwasher	murder
phrase	building	coffin	buckle
apathy	china	engine	olive
myth	cannon	gutter	neck
verb	diaper	bomb	cockpit
defeat	spinach	pencil	feet
interest	baseball	house	page
theory	paper	snake	cabbage
century	sign	cord	bolt
turn	church	lizard	grave
command	dump	shot	python

Form 2

List 1	List 2	List 3	List 4
church	house	phase	century
sign	engine	grudge	turn
cannon	snake	item	phrase
diaper	dishwasher	pardon	apathy
baseball	knife	idea	discord
building	coffin	method	fate
propeller	gutter	excuse	command
dump	lizard	guilt	theory
beggar	cord	knowledge	verb
china	square	folly	defeat
paper	shot	question	debt
miles	bomb	clue	interest
spinach	pencil	grammar	myth

List 5	List 6	List 7	List 8
money	bill	duty	trouble
page	train	science	accord
python	telephone	liberty	hazard
neck	web	belief	cause
murder	ammonia	audition	cure
olive	club	pronoun	safety
cabbage	gravel	plan	trust
bolt	mermaid	fear	plea
grave	battle	span	lure
car	jail	account	meeting
feet	insect	adverb	prefix
buckle	goat	wisdom	fact
cockpit	court	worth	eternity

Form 3

List 1	List 2	List 3	List 4
question	discord	feet	spinach
guilt	command	cockpit	diaper
excuse	myth	neck	china
item	defeat	page	paper
grudge	interest	cabbage	cannon
clue	turn	bolt	sign
phase	debt	money	dump
knowledge	century	car	baseball
pardon	phrase	olive	propeller
grammar	apathy	buckle	church
method	verb	murder	beggar
folly	theory	python	building
idea	fate	grave	miles

List 5	List 6	List 7	List 8
span	hazard	jail	pencil
account	meeting	battle	bomb
fear	plea	insect	square
worth	eternity	club	knife
duty	fact	mermaid	snake
liberty	accord	goat	house
adverb	trouble	bill	cord
science	cause	court	gutter
audition	safety	web	engine
belief	lure	telephone	coffin
plan	trust	train	lizard
pronoun	prefix	gravel	shot
wisdom	cure	ammonia	dishwasher

Form 4

List 1	List 2	List 3	List 4
train	fear	baseball	folly
court	adverb	dump	grammar
gravel	plan	building	question
insect	span	china	pardon
bill	science	beggar	guilt
mermaid	duty	miles	grudge
web	audition	paper	knowledge
goat	pronoun	cannon	item
ammonia	worth	church	clue
club	liberty	sign	phase
telephone	wisdom	propeller	idea
jail	account	spinach	excuse
battle	belief	diaper	method

List 5	List 6	List 7	List 8
shot	interest	eternity	grave
cord	apathy	prefix	python
house	theory	lure	buckle
bomb	discord	fact	cabbage
engine	fate	hazard	neck
dishwasher	phrase	cure	feet
knife	myth	accord	olive
square	turn	trouble	money
coffin	century	plea	cockpit
2gutter	debt	cause	bolt
pencil	command	safety	car
snake	verb	meeting	murder
lizard	defeat	trust	page

Form 5

List 1	List 2	List 3	List 4
meeting	knowledge	club	worth
safety	item	insect	liberty
cure	grudge	ammonia	audition
accord	clue	telephone	fear
plea	guilt	web	pronoun
fact	phase	court	wisdom
lure	pardon	battle	account
trust	idea	jail	adverb
prefix	question	goat	belief
hazard	excuse	mermaid	duty
cause	grammar	bill	span
eternity	method	train	science
trouble	folly	gravel	plan

List 5	List 6	List 7	List 8
fate	miles	knife	car
debt	beggar	square	money
discord	propeller	dishwasher	murder
phrase	building	coffin	buckle
apathy	china	engine	olive
myth	cannon	gutter	neck
verb	diaper	bomb	cockpit
defeat	spinach	pencil	feet
interest	baseball	house	page
theory	paper	snake	cabbage
century	sign	cord	bolt
turn	church	lizard	grave
command	dump	shot	python

Form 6

List 1	List 2	List 3	List 4
church	house	phase	century
sign	engine	grudge	turn
cannon	snake	item	phrase
diaper	dishwasher	pardon	apathy
baseball	knife	idea	discord
building	coffin	method	fate
propeller	gutter	excuse	command
dump	lizard	guilt	theory
beggar	cord	knowledge	verb
china	square	folly	defeat
paper	shot	question	debt
miles	bomb	clue	interest
spinach	pencil	grammar	myth

List 5	List 6	List 7	List 8
money	bill	duty	trouble
page	train	science	accord
python	telephone	liberty	hazard
neck	web	belief	cause
murder	ammonia	audition	cure
olive	club	pronoun	safety
cabbage	gravel	plan	trust
bolt	mermaid	fear	plea
grave	battle	span	lure
car	jail	account	meeting
feet	insect	adverb	prefix
buckle	goat	wisdom	fact
cockpit	court	worth	eternity

Form 7

List 1	List 2	List 3	List 4
question	discord	feet	spinach
guilt	command	cockpit	diaper
excuse	myth	neck	china
item	defeat	page	paper
grudge	interest	cabbage	cannon
clue	turn	bolt	sign
phase	debt	money	dump
knowledge	century	car	baseball
pardon	phrase	olive	propeller
grammar	apathy	buckle	church
method	verb	murder	beggar
folly	theory	python	building
idea	fate	grave	miles

List 5	List 6	List 7	List 8
span	hazard	jail	pencil
account	meeting	battle	bomb
fear	plea	insect	square
worth	eternity	club	knife
duty	fact	mermaid	snake
liberty	accord	goat	house
adverb	trouble	bill	cord
science	cause	court	gutter
audition	safety	web	engine
belief	lure	telephone	coffin
plan	trust	train	lizard
pronoun	prefix	gravel	shot
wisdom	cure	ammonia	dishwasher

Form 8

List 1	List 2	List 3	List 4
train	fear	baseball	folly
court	adverb	dump	grammar
gravel	plan	building	question
insect	span	china	pardon
bill	science	beggar	guilt
mermaid	duty	miles	grudge
web	audition	paper	knowledge
goat	pronoun	cannon	item
ammonia	worth	church	clue
club	liberty	sign	phase
telephone	wisdom	propeller	idea
jail	account	spinach	excuse
battle	belief	diaper	method

List 5	List 6	List 7	List 8
shot	interest	eternity	grave
cord	apathy	prefix	python
house	theory	lure	buckle
bomb	discord	fact	cabbage
engine	fate	hazard	neck
dishwasher	phrase	cure	feet
knife	myth	accord	olive
square	turn	trouble	money
coffin	century	plea	cockpit
gutter	debt	cause	bolt
pencil	command	safety	car
snake	verb	meeting	murder
lizard	defeat	trust	page

APPENDIX B

A PORTION OF THE HEALTH AND DAILY LIVING FORM

Name ______________________________

Age ________________ Sex __________

Please think of an important problem you have had in the last year. Write down, very briefly, what this problem was. This information, like all other information obtained in this study, will be kept in the strictest confidence.

____

____

Please indicate which of the following you did in connection with this event. For each item, use the following scale, writing down the appropriate number next to each statement. You must enter a number for each of the following activities.

1 not at all
2 yes, once or twice
3 yes, sometimes
4 yes, fairly often

_____ Tried to find out more about the situation

_____ Prayed for guidance and/or strength

_____ Took it out on other people when I felt angry or depressed

_____ Talked with spouse or other relative when I felt angry or depressed

_____ Prepared for the worst

_____ Kept my feelings to myself

_____ Talked with a friend about the problem

_____ Tried to see the positive side of the situation

_____ Talked with professional person about the problem (e.g., lawyer, clergy, doctor)

_____ Avoided being with people in general

_____ Considered several alternatives for handling the problem

_____ Refused to believe that it had happened

*****COMPLETE ALL ITEMS ON THE BACK OF THIS PAGE*****

1 not at all
2 yes, once or twice
3 yes, sometimes
4 yes, fairly often

____ Got busy with other things to keep my mind off the problem

____ Drew on my past experiences

____ Tried to reduce tension by drinking more

____ Tried to reduce tension by eating more

____ Made a plan of action and followed it

____ Took things a day at a time

____ Tried not to act too hastily or follow my first hunch

____ Tried to reduce tension by smoking more

____ Tried to step back from the situation and be more objective

____ Got away from things for a while

____ Went over the situation in my mind and tried to understand it

____ I knew what had to be done and tried harder to make things work

____ Told myself things that helped me feel better

____ Tried to reduce tension by taking more tranquilizing drugs

____ Let my feelings out somehow

____ Made a promise to myself that things would be better next time

____ Sought help from persons or groups with similar experiences

____ Accepted it; nothing could be done

____ Bargained or compromised to get something positive from the situation

____ Tried to reduce tension by exercising more

APPENDIX C

INSTRUCTIONS TO SUBJECTS

It is important that you follow these instructions when trying to remember the following lists of words.

USE WHATEVER STRATEGY WORKS THE BEST FOR YOU

Use this method to remember as many words as you can. If you have any questions about this, raise your hand and the experimenter will come to your chair to assist you.

It is important that you follow the above instructions when trying to remember the lists.

It is important that you follow these instructions when trying to remember the following lists of words.

REPEAT THE WORDS SILENTLY TO YOURSELF

Use this method to remember as many words as you can. If you have any questions about this, raise your hand and the experimenter will come to your chair to assist you.

It is important that you follow the above instructions when trying to remember the lists.

It is important that you follow these instructions when trying to remember the following lists of words.

FORM A MENTAL IMAGE OF EACH INDIVIDUAL WORD

For example, if the words were "boy" and "tree," you should first imagine a boy, then form a separate mental picture of a tree. Use this method to remember as many words as you can.
If you have any questions about this, raise your hand and the experimenter will come to your chair to assist you.

It is important that you follow the above instructions when trying to remember the lists.

It is important that you follow these instructions when trying to remember the following lists of words.

FORM MENTAL IMAGES OF THE WORDS TOGETHER

For example, if the words were "water," "boy," and "tree," you could imagine a boy watering a tree. Use this method to remember as many words as you can. If you have any questions about this, raise your hand and the experimenter will come to your chair to assist you.

It is important that you follow the above instructions when trying to remember the lists.

In trying to remember the word lists, which method did you use?

____ repeated them silently to myself
____ formed separate images or mental pictures of individual words
____ formed images or mental pictures that included several words together
____ some other strategy (describe)

Return the entire packet to the envelope provided.

APPENDIX D

INFORMED CONSENT FORM

INFORMED CONSENT

I understand that this study involves the study of memory functioning. I understand that there are no invasive procedures involved in this study and that all information I provide will be kept in the strictest confidence. I understand that I may withdraw from this study at any time without penalty.

____
Student's name (printed)

____
Student's signature

____
Date

____
Experimenter

APPENDIX E

TRANSCRIPT OF AUDIOTAPED INSTRUCTIONS

You will hear some lists of words. Pay careful attention to these words. After each list is presented, you will be asked to write down as many words as you can remember, in any order, in the booklet provided. You will have a minute and a half in which to write down the words. Use a liberal strategy in writing down your answers; that is, write down your guesses, even if you are not certain if they were on the list. You will sometimes hear a loud word in a list. You should try to remember these words just as you will all the other words. Each list will begin with the signal "ready." Do not write down the word "ready."

In a moment, you will be asked to open the packet you were given. When asked to do so, open the packet and read the instructions on the first page of the booklet. If you have any questions about what you are asked to do, raise your hand and the examiner will come to your seat to assist you.

Open the packet now and read the enclosed instructions.

APPENDIX F

TRANSCRIPT OF DEBRIEFING

The study you just participated in concerned the way in which we learn and remember information. This study looked at how emotional arousal and mental imagery change our ability to learn and remember words. Some of the word lists you just heard had words that were easy to make pictures of --snake, train, and diaper. Other lists were made of words that were more abstract and harder to picture--debt, verb, and plan. Some lists had a very loud word that made many of you jump in your seats: that is how we caused some lists to be high in arousal value. The purpose of this study was to see if the imageability of the words and whether or not you were startled caused a difference in your ability to remember the words. There were two other variables. One was encoding strategy. Most of you were told to use a specific method in remembering the word lists, and a few of you were asked to use whatever method works best for you. We wanted to see if the method you used to learn the words was important in how many words you remembered. Finally, the questionnaire you completed when you first came in asked about ways that you deal with stressful events. We want to know if the way you deal with a stressful situation has anything to do with your ability to remember words when you are emotionally aroused. Are there any questions?

Thank you for participating in this experiment. Please do not tell anyone else the details about this experiment, since they may sign up and participate at some time. If they do participate, it is best that they don't know the specifics about the study in advance.

APPENDIX G

MEANS AND STANDARD DEVIATIONS TABLES, BY INSTRUCTIONAL SET, IMAGERY VALUE, AND AROUSAL

Rote Rehearsal Group

HIA	X	2.500	2.000	1.333	1.042	1.583	3.167
	SD	1.319	1.383	1.049	0.908	1.176	0.637
HIN	X	2.625	1.583	1.709	2.042	2.333	3.042
	SD	1.135	1.213	1.083	1.160	1.239	1.082
LIA	X	2.708	1.250	0.958	1.458	1.583	2.750
	SD	1.233	0.944	1.083	1.103	1.060	1.113
LIN	X	2.375	1.167	1.042	1.125	1.833	3.125
	SD	1.055	0.917	0.999	0.850	0.917	0.680

Separation Imagery Group

HIA	X	2.625	1.667	1.208	1.083	1.292	3.083
	SD	0.970	0.917	1.021	1.018	0.859	0.776
HIN	X	2.417	1.458	1.375	1.833	1.875	3.208
	SD	1.213	0.977	1.013	0.702	1.116	0.932
LIA	X	2.292	0.958	0.833	0.958	1.458	3.000
	SD	0.955	0.908	0.816	0.999	1.141	1.063
LIN	X	1.167	1.250	0.750	1.042	2.583	3.333
	SD	1.090	1.225	0.737	0.955	0.830	0.868

Relational Imagery Group

HIA	X	2.375	1.667	1.792	1.667	1.375	2.958
	SD	1.100	1.050	1.250	0.917	1.135	1.083
HIN	X	2.500	2.000	1.000	1.708	1.583	3.292
	SD	1.216	1.103	1.180	0.690	1.060	0.751
HIA	X	2.125	0.833	1.083	1.333	1.917	3.000
	SD	1.262	0.917	0.830	0.963	1.213	0.978
HIN	X	1.708	1.083	1.125	1.292	2.083	3.042
	SD	1.459	0.880	1.076	0.751	1.061	0.908

Uninstructed Group

HIA	X	2.875	2.000	1.208	1.583	1.875	3.042
	SD	1.329	1.216	1.141	1.213	1.454	1.083
HIN	X	3.000	1.958	1.375	1.583	2.375	2.917
	SD	0.978	1.334	1.096	0.830	0.824	1.060
LIA	X	2.417	1.542	0.542	1.167	1.875	2.583
	SD	1.349	1.141	0.779	1.167	1.154	0.974
LIN	X	2.083	1.208	1.292	1.125	2.000	2.708
	SD	1.139	1.062	0.999	1.076	0.932	0.908

GRADUATE SCHOOL
UNIVERSITY OF ALABAMA AT BIRMINGHAM
DISSERTATION APPROVAL FORM

Name of Candidate Kinta Marie Parker

Major Subject Medical Psychology

Title of Dissertation Effects of imagery, arousal and encoding strategy on free recall in a von Restorff study

Dissertation Committee:

Linda W. Duke, Chairman

Robert D. Stambrook

Director of Graduate Program

Dean, UAB Graduate School

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