EXAMINATION OF FALSE RECALL AND

RECOGNITION USING THE

DRM PARADIGM

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CHAPTER I

INTRODUCTION

Examination Of False Recall And Recognition Using The DRM Paradigm

This dissertation will examine the Deese-Roediger-McDermott (DRM) paradigm

with a focus on the manipulation of semantic characteristics of the critical items as well

as examining how depth of processing can influence the production of false memories.

The study of false memory production has become a relatively popular area to study ever

since Roediger and McDermott (1995) reintroduced James Deese's (1959) early work on

associative processes among words. The area of research in the malleability of memory

has culminated with the work of Elizabeth Loftus (1993) and Schacter (1997) focusing on

how information given to individuals can influence their ability to accurately recall an

event. The Roediger and McDermott studies focus on how interrelated words in a list can

bring about the production of false alarms or memories without introducing extraneous

post-event information. Memory distortion and false memory production attempt to

explain the process of memory storage and retrieval in relation to why and how memory

can be adversely affected. Before a review of the literature is examined a statement of the

research problem will be presented.

Statement of the Problem

With the increasing interest in examining the possible causes and influences of

false recognition the following experiments are presented. The experiments that have

been developed by Roediger and McDermott (1999) can be used as a tool to develop an

experimental design that attempts to explain the most important aspects of false

recognition. This dissertation examined three different variables that influence the

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development of false memories. These variables are depth of processing, concreteness of the critical items and word frequency of the critical items. The Deese-Roediger-McDermott (DRM) word lists were used in this dissertation. Each list was chosen based on there concreteness and word frequency rating. Roediger and McDermott (2000) have developed 55 different lists consisting of 15 words with an associated critical item for each list. Each list has all the normed values listed in regard to word frequency, and concreteness. The lists were chosen so that all lists had similar mean associative strengths between the critical item and the items within each respective list. This was done to make all lists equal in regard to associative strength.

Objectives

The objectives of these studies are: 1) to assess the contributions of each variable on the proportion of individuals that falsely recall the target item; 2) to examine the reaction times of the various groups to assess the effect that word frequency, concreteness and depth of processing has on overall speed of retrieval of the target items; 3) to assess how depressed participants perform in comparison to non-depressed participants.

To begin an inquiry into the area of false memory production one must examine the early research that supplied the basis for further study of false memory. This is followed by a discussion of current models of memory and theories on processes that may influence memory. This chapter concludes with a review of current research in the field of both memory malleability and false memory production.

CHAPTER II

REVIEW OF LITERATURE

Ebbinghaus and Bartlett's Early work on Memory

The beginning of a systematic scientific study of memory started with Hermann

Ebbinghaus with his examination of memory using nonsense syllable (Ebbinghaus,

1913). Ebbinghaus sought to use memory research as a tool to show that applied areas of

research can be done in psychology. This is contrary to what Wundt had earlier proposed.

Wundt advocated that psychology should examine non-applied areas of research (Wundt,

1897). Ebbinghaus countered this by using strict controls and solid experimental designs

to give credence to the feasibility of research into applied areas and the examination of

learning and memory.

Ebbinghaus approached the study of memory by describing the memory system as

being made up of associations (Fancher, 1990). This is similar to the ancient Greek

theory of associative memory. The significant contribution that Ebbinghaus made in the

arena of memory and psychological inquiry in general was that he introduced strict

experimental controls when performing his experiments on memory. This was significant

not only for the domain of memory research but also to help the fledgling field of

psychology gain scientific credibility during the early 1900's (Hakes, James & Young,

1964).

The basis of the Ebbinghaus experiments was to learn and memorize a list of

nonsense syllables. The list of nonsense syllables was made by taking two consonants

and one vowel. The vowel would be in the center with the consonants on either side.

These nonsense syllables were used in an attempt to eliminate confounds which could

occur when one uses familiar words. That is to say, that each participant brings with them their own set of ideas and associations with certain words and this would be impossible to control. Also, Ebbinghaus found that by using nonsense syllables he would be able to get within word variations; that is, some words are simply easier to remember than others as well as some words having natural associates with other words.

Ebbinghaus obtained four major results from his experiments (Hoffman, Bringmann, Bamberg & Klein 1987). First was what he called a 'savings time'. This was the amount of time to relearn material subtracted from how long it took to originally learn the material (Ebbinghaus, 1913).

Second, Ebbinghaus also found the effect of over-learning. He discovered that over-learning material caused him to be able to relearn the list more quickly and easily.

Another effect examined was related to the amount of material that was to be studied. He indicated that as the amount of material increased the amount of time needed to learn it increased as well. He found that this was not a linear function of amount of material to amount of time but rather it was a more geometric increase of time to amount. Hunter (1966) describes this result in the following table :

Table 1. *Ebbinghaus Results*

Minutes	5	14	37	93	195
# words	24	48	100	200	300

This effect was an important piece of information for the development and understanding of the short term memory systems that was to come in the future.

Another effect that Ebbinghaus observed was that he was more easily able to learn a list if the items were spread out over time. He observed that the spacing of the trials was very important to accurate recall of the lists (Ebbinghaus, 1913).

The final and perhaps most important finding that Ebbinghaus contributed was that of the Serial Position Effects. He found that items could be either more easily or less easily recalled based on the position that they were found in the list. The results indicated that items in the early or first part of the list were easiest to remember followed by items at the end of the list. Items in the middle of the list were the most difficult to recall. These findings contributed immensely to the development of current memory models as well as gave impetus to more studies that examined these effects.

In addition to savings time, overlearning, and spreading of material, he also investigated primacy and recency effects. Primacy and recency refers to words at the middle of a list being harder to recall then items in the beginning or end of the list. This is caused by interference of items within the list. That is, items early in the list stand out and are not as susceptible to interference as items presented in the middle of the list. Items in the middle of the list have words presented before and after them so it is harder to recall as many of these as accurately. The items at the end of the list are recalled easier since they can be recalled immediately. Another effect that was found within the serial position effects is that of distinctiveness of items. The more distinctive the word the more likely it is to be remembered. Current researchers are using this paradigm to examine the development of false memories (Roediger & McDermott, 2000).

Ebbinghaus's research was very important to the development of theories of memory. He contributed new data to memory research generated by his nonsense syllable

experiments. Some of Ebbinghaus' research led to criticisms of it that were concerned with ecological validity. To counter that, one must realize that basic research is needed to come up with advanced ideas about the processes of memory. Ebbinghaus' basic research led directly to, and still influences, much research on memory today.

The concern with a more ecologically valid study of memory was performed by Bartlett. He was interested in how folk tales or legends were formed and propagated and how memory was involved in all of this. His book 'Remembering' (1932) described the construction and reconstruction of memory for stories that were told. The premise behind this research was that an individual would be told a story and s/he would have to retell it to another individual. Bartlett was one of the first researchers to call the events for a memory a 'schema' or map of events to be remembered.

Bartlett would present a picture or story to a participant and ask that person to recall it at various intervals of time such as days or weeks later. He then examined the inconsistencies that were generated as this participant described the memory for the event. Bartlett noted that many errors occurred and noted how memory was very constructive. This research led directly to much of the inquiry into 'False Memory' and eyewitness testimony studies of today which are described later in this paper (Loftus, 1979, 1993).

Another interesting effect that Bartlett discovered was found during the process of 'repeated production'. This was performed by having the participant recall the same event over and over again at given intervals. The result was that if the reproductions were done frequently enough the memory was found to become fixed and accurate. This followed Ebbinghaus's results of stretching out the training intervals for better recall.

Bartlett also found that if the participant was given long intervals between reproductions of the material then the memory for the story would gradually transform. This process of transforming the memories for the stories was called 'construction'.

The next type of study that Bartlett performed was the Method of Serial Reproduction (1932). This was accomplished by telling one person the original story in detail then that person tells another person and then that person tells another and so on. This procedure was directly related to his examinations for the development of legends and folk tales. The results are very relevant to memory. The results indicated that the story itself was much shortened by each participant. The more versions generated by the participants in the study, the less material is taken out until finally the story takes on a more coherent form.

This ecological examination of memory raises questions such as how much can the human brain process at any one time and what role does language have in memory. It can be seen that the gist of the story is being retained in a minimal form since short term memory has limited allocated resources. These findings help lead researchers to examine exactly how much information one can store at a given time and to propose systems to explain these events or stories are stored (Miller, 1956). These questions will be assessed in later chapters on working memory and language.

Bartlett also proposed that schemas for the stories had an impact on the reproduction of the story. A schema is a pattern or set of expectations that a person has of an event. The reconstruction of the story is also affected by the individual's past experiences and expectations for events. The person's background also influences what was remembered and recalled in the story. Items that were consistent with the

participant's schema of events influenced the reconstruction of the story and hence determined what was subsequently remembered. He found that the interpretation of the story played a key role in the construction of the material.

Bartlett's results suggest that memory is malleable and prone to reconstruction of events. It was not until the 1970's that these results were applied to society in the form of assessing accuracy and reliability of eyewitness testimony. Bartlett's experiments led to the development of much more research in the realm of reconstruction of memory that was to follow.

Deese's Memory research

James Deese developed a paradigm in the late 1950's designed to study how associative strength between words influenced recall. His research examined the influence of associations among items and memory for these items (Deese, 1959). Deese began studies into recall and memory based on his observations of the serial reproduction experiments that Bartlett began (Bartlett, 1932). Deese was interested in examining what caused the changes in the reproduction of stories from one person to the next. He hypothesized that these changes occurred because of individual differences in free association among words. His studies examined the exact nature of these differences among participants and attempted to explain how this variability of free associations arise. He found that if lists of words are highly associated together then the these lists are recalled with a greater degree of accuracy (Deese, 1959, 1961).

Desse (1959) examined the effect of the independent variable 'inter-item associative strength' on immediate free recall. He defined inter-item associative strength as "the average relative frequency with which all items in a list tend to elicit all other

items in the same list as free associates" (Deese, p.305). He explained that if the items within a list are strongly associated then the frequency of eliciting an associate that is not on the list is high. The first hypothesis presented by Deese was that associative strength would have a direct influence upon recall.

The second hypothesis was that associative strength was used as a type of mnemonic device in that the associations that were internally generated would help the participant recall the information (Deese, 1959).

Deese performed his experiments in two parts. First, he informed the participants that they would hear a list of items. These lists of words varied in their inter-item associative strength and were measured by the number of words recalled. At the end of the list the participants were told to write as many of the items down on paper as they could. This was the free recall portion of the study.

The second part of the study examined associations. This was done by having a list of highly related words, a list of minimally related words and a list of unrelated words. All three lists were related to a specific critical item, such as Butterfly or Sleep, but did not include those items. The results indicated that the lists that were highly associated had the highest incidence of false intrusions of critical items. Therefore, the recall accuracy of the participants was dependent on how strongly the associations within the list would elicit free recall of the other more associated items.

From his results Deese determined that false recall of extralist intrusion items ranged between 0 and 44%. He found a strong correlation between the associative strength of these words with proportion of false recall (Deese, 1959). His research focused on the possible explanations for this phenomenon, which he concluded was the

effect of associations among the items within the list. He developed thirty-six different lists that contained fifteen words each, with each list being made up of associated items relevant to the critical non-presented word. He found that as the strength of association between the items and critical word increased so did the occurrence of these extralist intrusions. These critical words were the unpresented words that are highly related to all the other 'non-critical' words in the list.

One of the first studies conducted following his initial research in 1959 supported the premise that words which are highly related with list items but not presented to the participants, will be recalled (Deese, 1961). In this study Deese had 90 participants hear one of three types of lists. Each group was made up of 18 lists composed of 15 words which were all presented by tape-recorder at 1.5 second intervals. The second group of participants heard 18 lists which were derived from successive recalls of the first 18 lists. The third group were given 18 lists that were derived from the successive recall of the second group.

The results from this study show that there is a linear relationship across the three groups (Deese, 1961). This means that as the words become more interrelated the number recalled increases with the number of derivations of the lists. It also showed that associative strength of lists help with recall and produces more relevant intrusions to recall. Deese further noted that original lists that were low in associative strength were made higher in associative strength by introducing related intrusions to the list. So that a list that once had little associative strength now contained more. Then the next participant who would hear this modified list would add even more intrusions to it making it even more strongly associated.

Deese replicated his earlier studies which revealed a significant correlation of .88 between the associative strength of the items and the mean frequency of recall (Deese, 1960). Further studies by Deese examined the effect that list length and frequency of the items within the list had on recall (Deese, 1961). He found that lists composed of high usage words and long lists elicited the most recall. The results of the study revealed a significant interaction between list length and inter-item word frequency. The data from Deese's study indicates that as list length and frequency increase, subsequent free recall of the items increase in a linear fashion.

These various studies over the years by Deese are very important to understand the nature of semantic relationships of items and possibly explain reasons for the generation of false memories. The results of his studies also lend support to current theories of language acquisition and structure such as the semantic spreading activation theory. Spreading activation is the activation of words that are interconnected in some way so that when one word is heard it activates words or concepts that are linked to it. Deese's work is intriguing because it predates the spreading activation concept. The utility of Deese's work is clearly seen by the interest in false memory studies and specifically the development of the Deese-Roediger-McDermott paradigm currently being used. Deese's work is integral to the development of false memory production experiments and the examination of possible factors that influence it, as this dissertation will address. Deese's results provided material for new findings in memory research which leads to the next area examining these different types of memory systems.

Information Processing Models (IP).

Perhaps the first theory of human memory developed in cognitive psychology was the information processing (IP) approach. George Miller (1956) developed this theory during his analysis of the amount of material that can be stored in short term memory at any one time. He presented a paper on how this magical 'number '7' kept recurring in everything from various studies of perception to attentive processes (Miller, 1956). The importance of an information processing theory was that it stimulated researchers to develop new theories of memory.

Researchers examining memory have presented two major theories of memory. The first is a multiple systems theory and a unitary system theory of memory. This evolution of two competing models has generated a great deal of research into empirically testing which of the two models is best.

The multiple memory systems theory proposes that there is more than one kind of memory or memory system and that these different forms of memory utilize different memory systems. The second theory describes a unitary or single memory theory. This theory proposes that all memory functioning is performed by one unified system. The most influential researchers into the development of the multiple memory theory were Atkinson and Schiffrin (1968).

The multiple memory system can be viewed as made up of three storage systems made up of the sensory store, short term store and long term stores. The major assumption of this theory is that it assumes that each store is distinct and separate. The unitary model states that there is only one memory that makes no distinction between

short term and long term memory. These memory models were generated by early

researchers on memory which will examined next.

Early Models of Memory

The general approach to information processing theory of memory began the

proposed model by William James (1890). This model consists of Primary and Secondary

memory. Primary memory refers to current occurrences or things that are happening at

that moment. Secondary memory refers to permanent experiences. This model had great

heuristic value to the development of cognitive science as a whole in that it allowed

researchers to test this model. Experiments by Peterson and Peterson (1959) and

Ebbinghaus were conducted within the memory model proposed by James. Figure 1

shows this first stage in the evolution of the information processing model.
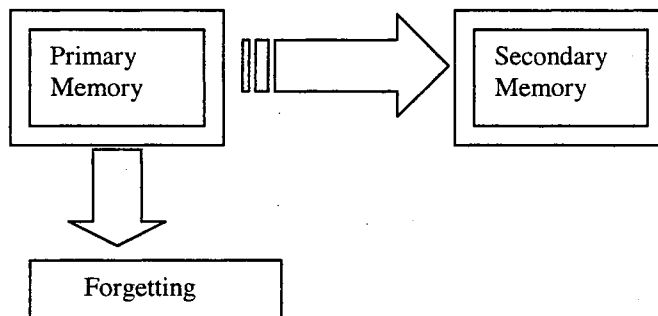
Figure 1. *William James early model of memory.*

The model that followed James' was proposed by Waugh and Norman (1965).

This occurred almost 70 years after James presented his model. Waugh and Norman were

the first to quantify aspects of primary memory. They attempted to define properties of

primary memory and also proposed that it had limited resources. This was done by

having participants hear a list of sixteen numbers and then told to repeat one of the

numbers near the beginning of the list. They found that as the number of items between

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the target and the end of the list increased the participants ability to recall the target item decreased. This supported their proposal of primary memory having a quantifiable limited capacity.

Waugh and Norman incorporated systems for maintaining information in short term memory called rehearsal, a retrieval system, as well as renaming the memory stores short term memory and long term memory. They also added another important memory component that follows the information processing approach which is sensory memory. Sensory memory is basically the input that is received mostly from either visual or auditory senses. Much research currently has focused on these two types of sensory memories (Broadbent, 1958). The Waugh and Norman model added quite a bit more information to the study of memory. This model became even more elaborated upon by Atkinson and Schiffrin (1968). The Atkinson and Schiffrin model added a few more components to better explain the differences found between long term and short term memory. Figure 2 represents the Atkinson and Schiffrin model of memory.
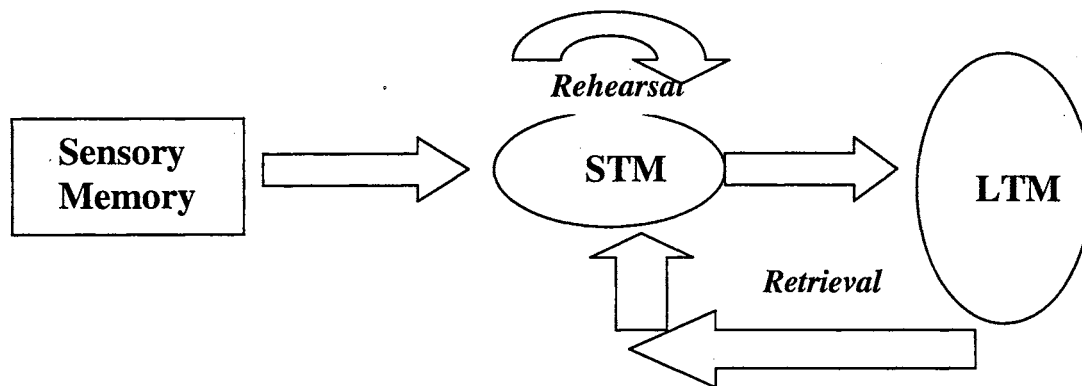
Figure 2. *Atkinson and Schiffrin Memory Model*

Now that an overview of the evolution of memory models has been given we can examine some of the key components within the memory system.

Short term vs. Working Memory

The Information Processing approach focused attention on the encoding, storage and retrieval of information. Much research on the encoding of information into memory focused on how information is stored over long periods of time. To answer this question the development of short term memory store was hypothesized. This store had limited capacity and was the 'place' where rehearsal of the material occurred. Currently, short term memory has been replaced with the term working memory based on the research of Baddley (1986). Working memory seems to be the more reasonable term since elaboration, rehearsal and other strategies for encoding information are assumed to take place there.

There are fundamentally two major ways that working memory and long term memory differ. The first difference that can be noted is that the capacity of each memory store is quite different. As seen previously, working memory has a very limited capacity in time and amount of material to hold information whereas long term memory has an unlimited capacity. The second is that the type of forgetting that occurs is based on different phenomena. In short term memory forgetting is primarily based on decay whereas in long term memory it is primarily done through interference. Much of the data for examining these memory systems is performed using words and sentences. Therefore it is important to examine some of the details of the use of language with psychological research. This field is called psycholinguistics and will be explored next.

Psycholinguistics, Memory & Lexical Decision Task experiments

The study of language and psychology have come together to form the area

known as psycholinguistics. Much of the current memory research uses lexical items

such as word lists, vignettes or paired associates. Therefore, it is important to review the

major ideas within psycholinguistics. Psycholinguistics deals with cognitive and

developmental aspects of language and how this complex system of communicates

concepts via symbols that represent information are transmitted. Psycholinguistics is

important for research and used in the dissertation since words are being used to test

memory and the second part of the experiment is a lexical recognition task.

The fundamental basis of language is memory. Therefore language can be used as

a way to assess how the brain processes information. The question that researchers have

sought to answer is how individuals access linguistic information. Also, researchers seek

to address how individuals are able to use and generate language.

Psycholinguistic research also examines reaction times in regard to lexical access

of words. The directionality of lexical processing has been studied with consistent results

being obtained (Moss et al., 1995). Research has shown that processing goes in a bi-

directional rather than unidirectional fashion. The research that has been performed to

support this finding generally deal with reaction time in lexical decision tasks. The ability

of lexical items to be accessed in both forward and backward semantic associates has

been demonstrated in priming tasks (Pratarelli, Perry, & Galloway, 1994). This illustrates

that activation of the lexicon is not a one way serial search, but rather a highly developed

parallel processing search.

Parallel processing has led to research on spreading activation (Anderson, 1983; Collins & Loftus, 1975). Spreading activation occurs when activation of a word activates other words that are strongly associated with it. Much research has focused on the interconnectedness of lexical entries and the structure of this system based on a spreading activation model (Miller & Fellbaum, 1991). When a list of words that have similar contextual meaning are given to participants, words that were not in the original list are often recalled. This can be explained by the words being interconnected and becoming activated to lead to the recollection of a word that was not presented.

Another factor involved in spreading activation is that of neighborhood density. Neighborhood density is related to the number of surrounding words which impacts the speed of retrieval. Familiarity and categorical size of the specific lexical item to be retrieved also influences retrieval speed.

The paradigm of spreading activation has been further examined by researchers in the realm of affective cognition. Bower (1987) is one of the foremost researchers in this field and has shown that emotionally similar words seem to propagate the activation of each other. He has also presented results indicating that the mood of the individual will affect the types of lexical entries that are most easily retrieved. For example, if one is in a negative or depressed state, then the words that are most easily activated and recalled are likely to be of the type mirroring that state (Bower, Monteiro & Gilligan, 1978). Research such as Bowers led to more experiments examining how not only mood affects memory but the influence of time (decay) and interference has on memory.

Interference and Decay Studies and State/Context Dependent Memory

One of the most examined areas of memory are the possible causes of forgetting. There are two main theories related to forgetting. The first is interference. Interference refers to information that is already stored in memory interferes with the information that is to be retrieved. Research indicates that there are two main types of interference, proactive and retroactive which will be discussed. The second type of forgetting is based on time and is called decay.

An early study that examined the effect of interference on memory was conducted by Underwood (1954). An analysis of the studies done by Ebbinghaus was examined for possible causes of interference. Underwood and Ekstrand (1965) showed that the interference was caused by previous lists that were learned and not a general form of interference from everyday events. Previous work following the Ebbinghaus tradition showed a decrease in remembering over time, but did not test to see what was the cause of the interference.

The effect of time on forgetting was another area of interest to researchers. The pioneer in the area of memory decay was Brown (1958). He examined how various time intervals would effect recall. Wingfield and Byrnes (1972) examined the effect of decay in short term memory using Broadbent's (1958) dual listening task. Broadbent had proposed that there was a limited capacity filter that can pass information for encoding from only one channel at a time. This material is also greatly affected by time and was found to be about 1.5- 2 seconds for auditory or 'echoic' memory before it disappears. Further research on the limits of working memory were presented by Baddley (1990) and supported the two second time list for immediate memory. Whether interference or decay

was most important to forgetting was a central question to memory researchers during this time.

The question of whether interference or decay is most influential in forgetting has been debated over the past forty years. Each theory has much supporting evidence for its efficacy for explaining forgetting. The interference effect is supported by a theory called the "fan effect" which is the more facts that are coupled or associated with an idea or concept, the slower it is to retrieve that piece of information.

Further research has shown that there are two types of interference which are proactive and retroactive interference. Proactive interference can occur when old material that is learned interferes with the learning of new material. Retroactive interference occurs when new learning interferes with the recall of old information. Other theories on interference result from experiments on the serial position effect. Since working memory has a limited capacity, it can quickly fill with information and this can cause forgetting of previous information. In the serial position effect one can clearly see the influence of proactive inhibition, which is when the words early in the list (primacy) are better recalled than the words in the middle of the list. Retroactive inhibition can be seen as the words that are last in the list (recency) are recalled more often than those items that are found in the middle of the list. The figure below displays the serial position effect that has been repeatedly confirmed in the literature.
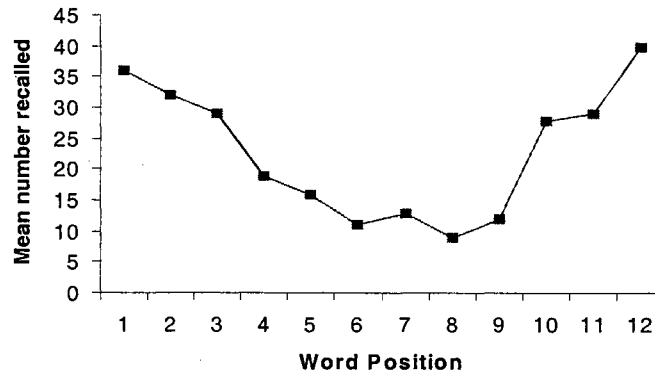
Figure 3. *Illustration of the Serial Position Curve.*

The next type of forgetting that has been studied deals with time and is called

decay. Many decay studies have been performed over the past several decades (e.g.

Waugh & Norman, 1965; Crowder, 1982; Hole, 1996). A popular theory related to

forgetting is called long-term potentiation (Anderson, 1975). This theory holds that

memories are kept intact by the constant reactivation of memory traces. If these memory

traces are not reactivated then the memory loses strength and disappears.

Another area of research that has been conducted is mood and context dependent

memory. Mood dependent memory was popularized as an area of research by Gordon

Bower in the 1970's. Bower (1981) published an important paper that dealt directly with

mood and memory. He described a phenomena called mood or state dependent memory

and the importance of mood congruency on retrieval. He found that mood can either

enhance memory if it is congruent or interfere with memory if it is incongruent.

Bowers experiments had participants learn a list of words in either a hypnotically

induced happy or sad state. They then learned a second list of words in either a happy or

sad state and finally recalled the original list in either a happy or sad state. The

manipulation of state was used to assess its effect on recall. Bowers explained that mood

influenced all facets of memory and the mood a person was in influenced free association

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of words and the types of events that individuals remembered. Table 1 show Bowers research design.

The results from Bowers experiment show clearly that the group that learned and recalled the list in the same state were significantly more accurate in their retrieval of the words than the group that had to recall the items in the opposite state. It also supports the notion that interference plays a role in memory. In the interference condition, when the same state is generated for list B and the recall state, participants had a much lower rate of recall of list A. This is because the state that list B was learned in matches the recall state and interferes with the accurate recall of the words from the original state which was the opposite of the recall state. The results show how mood can affect memory and this was a catalyst for a large body of research performed in the 80's and 90's.

Table II.

Bowers Mood and Memory Experiment

Learn list A	Learn List B		Recall List A
Happy ⟶	Sad ⟶	Best ⟶	Happy
	Happy ⟶	Control ⟶	Happy
	Sad ⟶	Interfere ⟶	Sad
Sad ⟶	Happy ⟶	Best ⟶	Sad
	Sad ⟶	Control ⟶	Sad
	Happy ⟶	Interfere ⟶	Happy
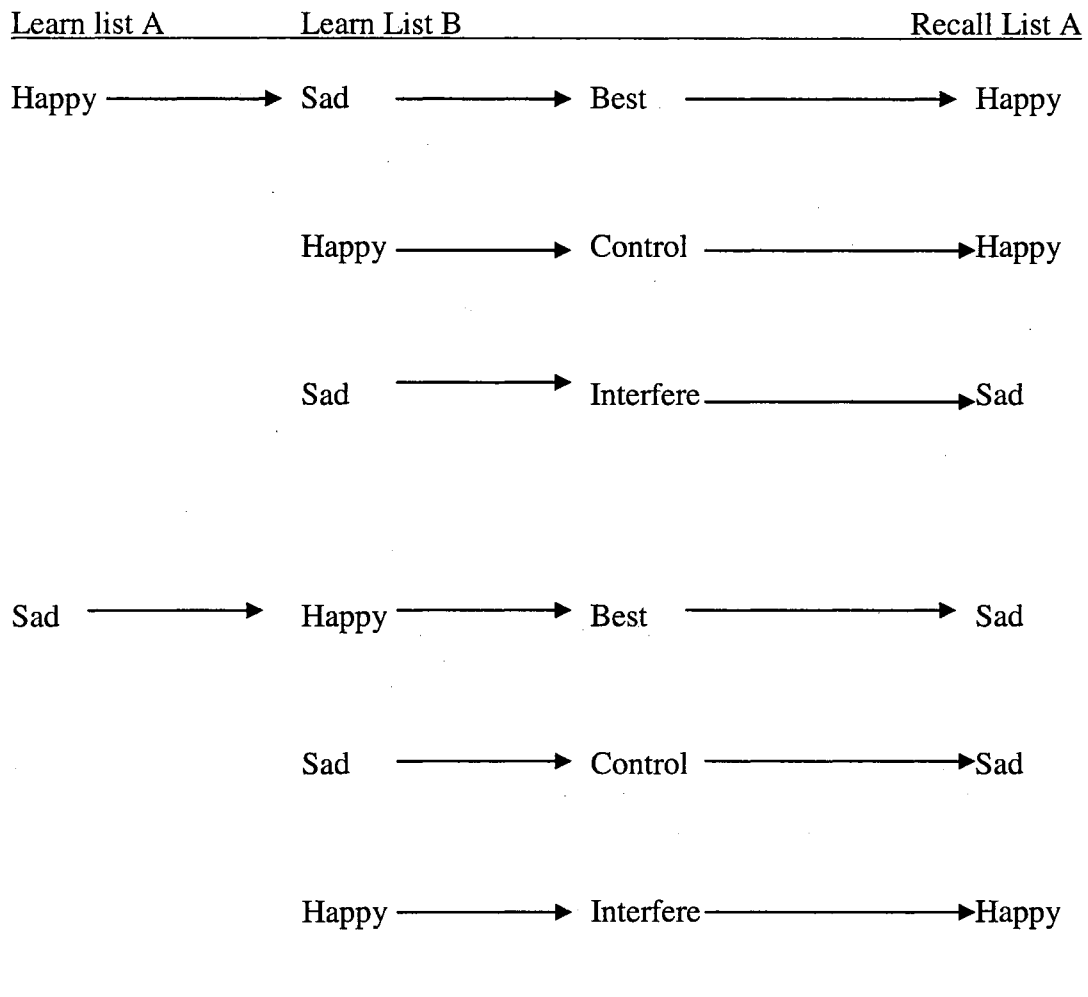
Previous research on mood and memory conducted at Oklahoma State University examined the effect of mood and memory using depressed individuals who were medicated, depressed individuals non medicated and non depressed individuals as controls (unpublished manuscript). The results of this study clearly showed an effect of mood on memory. The depressed individuals, both medicated and non medicated, recalled significantly more negative items than positive and neutral ones when compared to controls. Another interesting result was that the depressed individuals also generated more negative false memory for items that did not appear in the lists when they performed a recognition task. These results further support the notion that mood can greatly affect memory and more specifically the types of memories.

Other research in context dependent memory was performed by Godden and Baddley (1975). These studies examined the effect of the environment on learning. This research clearly showed that the environment plays a significant role in the encoding and subsequent retrieval of information. In this study participants either learned a list of words on land or underwater. They then had to recall this learned list either on land or underwater. The manipulation of the experiment entailed crossing the encoding environment with the recall environment. The results revealed that when the environments matched, that is if the participant had learned the list underwater and the recalled the list underwater, the participants were able to recall significantly more items than if the environments did not match. This study and others lend support to the interference effect on memory since the environment can be seen as interfering with subsequent retrieval of information (Abernathy, 1994; Alba, Alexander, Hasher & Caniglia, 1981; Smith, 1978; Smith, Glenberg & Bjork, 1978; Smith, 1979).

False Memory Studies

Research that stimulated the area of false memory production was performed by

Deese (1959) and Bartlett (1932). Deese was interested in the effect that 'paired

associates' had on the generation of false or incorrect recall of information. Research into

the effect of misinformation on false memory generation began being conducted during

the 1970's pioneered by Elizabeth Loftus (1979).

The false memory debate became an area of concern due to the prevalence of the

so called "recalled sexual abuse" issues that arose in the late 70's and early 80's. This

problem arose when individuals during counseling began to recall traumatic events that

supposedly happened in their early childhood. Further examination of these sexual abuse

cases revealed that many of them never had experienced abuse but falsely recalled these

events by information given by the therapists (Loftus & Palmer, 1984). Because these

events seemed so real to the individuals and due to the severity of the charges, research

began to examine how and why these individuals recalled events that never occurred.

Current therapists have become familiar with the phenomenon and no longer use

suggestive and hypnotic procedures when treating their clients. Also, many articles focus

on causes for the production of false or incorrect memories. Over the past decade a flood

of researchers examined the generation of false memories (Loftus & Palmer, 1984;

Loftus, 1991; Roediger & McDermott, 1995). Current researchers have been focused on

examining the effects of misinformation on recall, as well as the effects other factors such

as semantic associates, word frequency, word length and mood have on the development

of false or inaccurate recall (Loftus, Donders, Hoffman & Schooler, 1989).

The rise of constructionism in the 1970's led to an avenue of research to describe the processes behind false memory generation (Loftus, 1995). Constructionism is defined as a process where a gap in memory is reconstructed (Loftus, 1995). Neisser (1960) described memory as a process of construction.

The notion of constructionism led to the development of experimental models developed by Loftus using leading questions and post event information. The newest development in the false memory arena is that of source memory or source monitoring (Schacter, 1997). Source memory deals with a process that allows individuals to remember when, where and how they received the information that is to be remembered. By manipulating various aspects of the sources for memory, the frequency of false memory was decreased. Variables used in these studies included manipulating gender of the speaker, varying the modality of stimulus presentation and also changing characteristics of the stimulus items themselves as Bartlett did previously in 1932.

The generation of false memories can also be explained by examining the act of the retrieval process itself. Roediger, Wheeler and Rajaram (1993) showed that when participants in the study were told to guess during the recall process, the act of guessing became a source for generating false memories during subsequent retrieval of that list. That is to say that the participants thought that the items that were guessed originally became actual memories. They recalled with a high rating of confidence that the items that were guessed and not on the list originally became a false memory (Busey, Tunnicliff & Loftus, 2000).

The most influential researchers of false memories currently is Roediger and McDermott. They have published dozens of articles on false memory creation. In the

early 90's their research led to an experimental procedure they called the Deese-Roediger-McDermott method (DRM) that was modeled after Deese's 1959 study. They utilized this method to analyze the effect of both false recall and false recognition via the list learning method. The lists consisted of 12 words that were associated with a 'critical' word that was not presented (Roediger & McDermott, 1995 & 2001).

These experiments examined the number of times that a critical item was recalled. The list learning paradigm that is used also generated serial position effects that were examined. It was found that the non presented critical items were recalled at about the same frequency of those words that were found in the middle of the list. These results follow previous research that explain the process of schemas in memory as well as the implicit associative response. The implicit associative response is when a word is presented and individuals tend to automatically think of another word that is highly associated with it. Previous research on this issue was performed by Underwood and Ekstrand (1965).

Anderson and Bower (1973) described false memory generation as being derived from the words initiating the associated link to the critical word via a semantic network. This idea of spreading activation is currently a powerful theory to explain many of the false memory results. In the Roediger and McDermott's studies the lists of words that they used were all highly associated with the critical item. So when each word was presented it would activate within the semantic network the unpresented critical item. When this occurred repeatedly the participant would falsely recall that critical item although it was never actually presented.

Roediger and McDermott (2000) state there are two basic processes that influence errors in remembering. The first is simply forgetting an event or item that actually did occur. The second is remembering information that did not occur. The second type of error is what is most important to researchers. Studies have alluded to a number of ways that errors in memory are generated. The first way is that the information is not encoded properly at the time of presentation and therefore subsequent recalling of this information is degraded. Another source of error is that information already present within the individuals memory can influence both the encoding and retrieval of the information. Finally, memories can be altered by subsequent information given after the storage of the material has been completed.

In addition to remembering there is a third concept called priming which has been used to describe the false memory process (Roediger & McDermott, 1995). The words that are presented in the list can activate or 'prime' the target word so that an individual believes that they had heard the word in the list when they are asked to recall the list. They explained that individuals have high confidence ratings for hearing the unpresented word because it had been consciously thought of during the presentation of the list. These factors of priming and semantic activation has a tremendous influence in the production of false memories.

False memory experiments have led Roediger and McDermott and other researchers to examine variables that may play a role in producing false memories. Many studies have shown that rate of false memory generation is directly related to the number of items that are presented in the list (Hintzman, 1988; Shiffrin, Huber & Marinelli, 1995). Hintzman et. al found that lists containing less than 10 items had the lowest levels

of false recall whereas list containing more than 10 generated high levels of false recall, approximately 72%. Another aspect of the false memory phenomena is the extent of association between the critical items and the words presented in the list. A list of associations by Russell and Jenkin (1954) gives both back ward and forward associations between words. Roediger and McDermott (2000) examined the effect of backward associated words and forward associated words in regards to false recall.

Another variable attributed to false memory generation is the effect of depth of processing. Depth of processing is the amount of effort used to analyze pieces or chunks of information. Low depth of processing would be using very little effort in regard to analyzing the information whereas high levels of processing would be described as a more effortful process. Rhodes and Anastasi (2000) found that individuals who performed deeper levels of processing recalled significantly more list items and critical items. The levels of processing phenomena states that the more in depth processing an individual uses to study an item the higher likelihood it is that the item will be recalled (Craik & Lockhart, 1972; Cermak & Craik, 1979; Craik & Tulving, 1975).

The experiment included four lists of items containing 15 words. One group was told to count the number of syllables in the word as it was presented (the low level group) and the other group was told to imagine the item and rate whether it was concrete or abstract (the high level group). The results of the Rhodes and Anastassi's study showed that not only were the list items recalled significantly more often when processed deeply, the critical items were also recalled significantly more often. This is very interesting since one would expect that individuals who were able to process the lists at a higher level

should have increased accuracy for the times in the list and also should not recall items not on the list.

The best explanation for the higher rates of recall of the critical items for the high levels of processing groups is explained again by the spreading activation and semantic networking theories (Collins & Loftus, 1975). When one processes information deeply, these items implicitly activate items that are highly associated with them. With this deeper processing these links become more activated and thereby increase the likelihood of recalling the highly associated critical item.

In addition to general memory, mood has also been shown to influence the generation of false memories. Previous research has shown that mood does play a significant role in memory (Bowers, 1987). Moreover, if items to be remembered match the mood of the person encoding the material then an increase in overall accuracy is expected. Previous research on the Deese paradigm has not focused on this question and this dissertation will generate data as to the variability of depressed and non depressed individuals on false memory production. That is, the lists will not contain specifically negative or positive items, but rather overall processing of the information will be examined.

In addition to mood and false memory production, another area that can be viewed under this domain is that of eyewitness testimony. This area of research became very popular in the mid 1970's with researchers examining how individuals recall episodic types of events. Loftus (1979) was the premier researcher in eyewitness testimony and currently continues to publish on this topic. The eyewitness paradigm was very influential in the development and popularity of bringing back Deese's methods of

false memory generation. Prior to the eyewitness studies it was thought for many years that memory was much more accurate than it really is (Loftus, 1993). The inability to store a large amount of information into long term memory can be explained by the limited resources in working memory. These limited resources lead to exclusion of specific details in a crime scenario and these may be later filled in by leading questions, misinformation and misleading post event information.

The misinformation effect presented by Loftus has been replicated by other researchers (Wright, Self & Justice, 2000). The method used most often for misinformation and memory implantation is showing people photos of mechanics holding various tools, car crashes or crime scenes (Loftus & Pickrell, 1995; Loftus, 1997). Each of these various types of methodologies elicited about a 27% rate of false memory production.

The major difference between misinformation studies and semantic false recall studies is that misinformation is actually given to the participants after the faces or pictures are given, while in the word list paradigms the critical item is never introduced. Although both methods differ in the presentation of the stimulus items they examine the basic premise in memory recall, schemas. In the word paradigm a schema is activated for the critical non presented item while in the eyewitness studies a schema for a specific event is usually activated. The activation of the schema for either the word or event is what triggers the generation of the false memory.

Further examination of the false memory literature has led some researchers to rename this process. Payne, Neuschatz, Lampinen and Lynn (1997) presented the idea that the study of false memory should take on an analogous quality such as studying

perceptual illusions to examine the perceptual processes. They came up with the term

"memory illusions" after reviewing many experiments on false memory. This makes

sense in that the memory system can be studied indirectly by examining the generation of

memory illusions just as the Muller-Lyer illusion is used to examine perception. Payne et

al., explain that there is no real difference between perceptual and memory illusions and

that they both utilize external events to generate subjective phenomena. An internal

representation is made of the external world or events that are presented.

The results of studies by Roediger & McDermott (1997) indicate how compelling

these memory illusions can be. The participants in the false memory experiments stated

that not only did they feel certain that they heard the critical item but also stated that they

claimed to remember who had said the critical word. The premise of viewing false

memory as an illusion is that memory is itself an act of reperceiving events. That is, when

a memory is formed it is a representation of an external event. This external event is

encoded as a memory and therefore is inherently an internal representation. When this

memory is accessed it is this internal representation that is retrieved and can be said to be

'reperceived'.

An important area using the methods of false memory generation is assessing

memory impairment of aging individuals. Much research has been done concerning

Alzheimer's disease and other organic brain diseases found in the aging population.

Studies have begun to examine group differences on false memory generation and

memory accuracy in general. Searcy, Bartlett and Memon (1999) conducted a study on

age differences on face recognition and eyewitness identification. They found that

presenting post event information increased the rate of false identifications significantly for the older group but not the younger group.

Balota, Cortese, Duchek, Adams, Roediger, McDermott and Yerys (1999) found that older adults recalled fewer of the test items and those individuals with Alzheimer's recalled even less. With respect to the critical items it was found that Alzheimer's patients had the largest incidence of false recall, significantly more so than the two younger population samples. The use of false memory generating techniques can be viewed as a critical tool in developing models of memory as well as examining the various aspects that are involved in the encoding, storage and information of material. Future research on false memory is incorporating the use of PET scans and fMRI techniques to find the physiological components of these processes and to correlate them with cognitive theories of memory (Schacter, 1997).

CHAPTER III

HYPOTHESES

Hypotheses

The hypotheses and rationales for each part of the study are presented below.

Expected results for each hypothesis in this study are also presented.

Hypothesis 1: There will be significant differences based on frequency and

concreteness in regard to false production of the critical item.

Rationale: Frequency and concreteness have been shown to have an effect on

general recall and recognition memory so it is expected that these characteristics will play

a role in false production of these items.

Expected Results: The critical items that are highly concrete and high in

frequency would elicit the highest rates of false production.

Hypothesis 2: The group performing higher levels of depth of processing

(DOP) will significantly increase false memory production for the critical item.

Rationale: Depth of processing increases overall accuracy of both recall and

recognition of items. This variable will allow for examination of differences in false

memory production in relation to the other two semantic characteristics of the critical

item.

Expected Results: It is expected that the group processing material more deeply

will have greater accuracy but also should generate the most false recall of the critical

items since they will have a greater chance to activate the critical item based on the deep

processing of the lists.

Hypothesis 3: Reaction times will differentiate between depth of processing groups and reveal significant differences between the critical item and old items.

Rationale: Reaction times are accurate measures for differentiating amount of processing taking place for each stimulus. The reaction times for each group can be used to assess how the variables influence processing speed.

Expected Results: The groups highest in depth of processing will have the fastest reaction times since that group had sufficient opportunity to encode the stimuli at a deeper level than the low depth of processing group.

Hypothesis 4: There will be significantly higher rates of falsely recalled items for the recognition task than the free recall task.

Rationale: Recognition memory is based on cues given to the participants, thereby allowing them to decide whether they remember seeing the item. Free recall is more difficult and will generate fewer incidences of false memories.

Expected Results: It is expected that recognition memory results will have significantly more false productions of the critical items then in the free recall task.

Hypothesis 5: Groups will differ significantly based on mood (from the BDI/PANAS) in regard to the number of false memories and overall accuracy.

Rationale: Research has shown that there is a mood congruency effect as well as influencing processing speed and overall memory activity.

Expected Results: The depressed group will differ significantly both in terms of reaction times and number of false recall of critical items to the non depressed groups.

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CHAPTER IV

METHOD

Participants

Two-hundred-forty participants performed this experiment. A power analysis was performed which indicated that 14 participants per cell would be necessary to achieve a power level of .70. Thirty participants were randomly assigned to each of the eight conditions. Only right handed individuals with normal or corrected-to-normal vision were used and only those proficient with English. This restriction is needed since the stimuli used are all English words and individuals not familiar with the language will lead to extraneous variability in the data. All participants were drawn from the Oklahoma State University undergraduate population. Oklahoma state is a large southwestern university with as student population of approximately 16,000. All participants received extra course credit for their participation.

Materials

Lists. The lists that were used for the memory tests were picked from the 55 developed by Roediger and McDermott (2001). The lists were chosen based on the frequency and concreteness of the critical items only. All frequencies of the items were taken from Francis and Kucera's book containing word frequencies in the English language (Francis & Kucera, 1982). The concreteness ratings were obtained from the norms generated from Nelson (1999), Toglia and Bettig (1978) and also from research by Paivio, Yuille and Madigan (1968). See Appendix A for the lists.

The lists for each category were chosen based on how low or high there frequency and concreteness ratings were. For example, the critical item list for CAR, is coded as

being high frequency and high in concreteness. Therefore, it would be part of the high

frequency / high concreteness group. All frequency and concreteness ratings for each

critical item are given in Table 2. Five critical item lists were chosen to represent each of

the four low/high frequency and concreteness combinations. All lists are similar in

overall associative strength. All five lists within each condition are all similar in

frequency and concreteness.

Table III.

Frequency and Concreteness ratings of each critical item.

Low frequency/ Low Concrete				Low Frequency/ High Concrete		
Item	**Frequency**	**Concrete**		**Item**	**Frequency**	**Concrete**
SLOW	60	2.89		LION	17	6.14
SWIFT	32	3.31		SPIDER	2	5.95
FOOT	70	3.46		TRASH	2	5.76
ANGER	48	3.75		BREAD	41	6.18
ROUGH	41	3.48		CHAIR	66	6.12
Mean	*51.0*	*3.38*			*25.6*	*6.03*
High frequency/ Low Concrete				**High Frequency/ High Concrete**		
Item	**Frequency**	**Concrete**		**Item**	**Frequency**	**Concrete**
WISH	110	2.66		CAR	274	6.35
JUSTICE	114	2.18		CITY	393	5.41
HIGH	497	3.62		GIRL	220	6.83
BLACK	203	3.66		RIVER	165	5.83
COLD	171	3.67		WINDOW	119	6.27
mean	*219*	*3.15*			*234.2*	*6.14*

Apparatus forCollection of Behavioral Data.

A compact disc player was used to present the stimuli lists. All lists were created using a computer generated digital male voice. These lists were created as wave files which were then copied to a compact disc. Each list was set to have the exact same time between each stimulus word. Fifteen Pentium 500 computers were used for stimulus presentation and collecting manual reaction time responses from the participant. The test stimuli were set to remain on the screen for 1000 milliseconds since this was found to be the best length of time for brief encoding of the words from previous experiments done in this laboratory.

Seventy words were used as test items for the computer task. There were 30 items taken from each list (six words x five lists), 30 new words not previously presented in the lists, the five critical items, and five new words not presented but physically similar to the critical items. Seventy words were used to allow plenty of items to be averaged for reaction times as well as generate a cross section of list items actually presented.

The stimuli was presented in a random order on the screen for 1000 ms each. The participants responded using either the left or right hand indicating whether they had remembered hearing that word previously. The 'a' key and 'l' key were used as the trigger buttons for yes and no responses. The 'a' key and 'l' keys were set to be either yes or no prior to the beginning of the experiment. The counterbalancing of response hand is used to control for hemisphere effects and to take care of any of the "yes effect" phenomenon that may occur. The behavioral data obtained were analyzed using a C compilation program and stored in coded data files.

Procedure

Participants were randomly assigned, and evenly divided into one of the following eight word list combination groups/ depth of processing (DOP) groups (2 levels frequency by 2 levels concreteness by 2 levels DOP). Table 3 describes the group combinations. For the depth of processing groups, the low DOP group were told to count the number of syllables for each word presented. The high DOP group were told to imagine each item in the list. The word combination groups consisted of high or low frequency and high and low concreteness of the critical items. Each group received five lists that are characterized by one of the previous combinations of variables. Each list was presented one at a time with recall taking place after completion of each list.

Before the list procedure begins, all participants filled out a general demographics form. This was followed with the completion of the twenty item Beck Depression Inventory (Beck, 1971). Devilly (2001) has found that reliability of the BDI is high (coefficient alpha = .86). Validity of the measure has been assessed repeatedly by factor analysis and shown to be high (Richter, Werner, Heerlien, Kraus, Sauer, 1998). Once all participants in the group had completed the paper work, instructions were given on how to perform the experiment. The words were presented via a compact disc recording of the fifteen words spoken at three second intervals.

Each participant heard one type of the above lists based on their group. After the list had been given, a distracter task was given for two minutes. Two minutes has been found to be a long enough interval to diminish the recency effect in recall (Schacter, 1998, Roediger & McDermott, 1999). At the end of the two minute interval the participants wrote down as many words as they could recall in any order. Following the

completion of the free recall tasks the participants performed a recognition memory task

on the computer. There were 70 words presented on the computer screen during this task.

The words presented contained the 30 items previously presented verbally, 30

items that were not presented, the five critical items and five items that look similar to the

critical item. The words were presented on the screen for 1000 ms with a 3000 ms inter-

stimulus interval. The stimulus interval of 1000 ms is standard for recognition

experiments and the 3000 ms inter stimulus interval allowed the participant to prepare for

the onset of the next stimulus. All stimuli were presented in a random fashion. The

recognition task was performed on computer so that reaction times could be obtained as

well as number of items correctly and incorrectly recalled.

The participants were seated in a chair with a 15-inch computer monitor facing

them in the computer lab. The keyboard was placed in front of the participant and the

instructions and practice set were given at that time. The instructions to the participant

were to look directly at the center of the screen. The participant was instructed to use

either their left or right index finger for making a positive or negative response when the

stimuli appear on the screen. They were told to respond as quickly and accurately as

possible to the words that appear on the computer screen.

After the computer task was finished, participants were debriefed about the

experiment and asked if they had any questions. Once the participant was finished, the

data were cleaned in DOS and analyzed, and transferred to a data output file that was

used for statistical analysis in SPSS. Any participant that scored above a 17 on the BDI

was not used in Experiment 1. They were used in Experiment 2 and matched with a

control participant from Experiment 1. For example, if a participant with a BDI score of

20 was in the high depth of processing, high frequency and high concrete group, they

were matched with a control participant from the same group from Experiment 1.

Table IV.

Designations of the Groups by Variables.

Critical Item List Type

1. low frequency-low concreteness
2. low frequency-high concreteness
3. high frequency-low concreteness
4. high frequency-high concreteness

CHAPTER V

RESULTS

The data obtained for Experiments 1 and 2 were examined for outliers and normality of distributions. Frequency analyses were performed to check for any outliers, missing data, and data entry errors. The total number of participants was two hundred sixty-two. Of these, 240 were used for Experiment 1 and sixteen were used in Experiment 2. The participants that scored seventeen or above on the BDI were excluded from Experiment 1 and used for Experiment 2 (n = 16). Six participants' data were dropped due to missing data and/or English was not their first language.

Experiment 1.

The first analysis examined the effect of depth of processing, word frequency and concreteness on the number of critical items falsely recalled. A 2 x 2 x 2 analysis of variance was performed on these variables which failed to produce a significant three way interaction. However, the main effect of concreteness was significant, F (1, 232) = 72.55, $p < .001$, $\eta^2 = .24$ and the main effect of depth of processing was also significant, F (1, 232) = 22.77, $p < .001$, $\eta^2 = .090$. Figure 4 displays the main effect for depth of processing. Figure 5 shows the main effect of the concreteness variable. The high concrete groups had significantly more false recall of critical items than the low concrete groups (M = .25 vs. M = .49). Also, the high depth of processing group produced significantly more recall of the critical items than did the low processing group.

A significant two way interaction was found between depth of processing and concreteness, $F(1, 232) = 7.40$, $p < .01$, $\eta^2 = .031$. Figure 6 shows this interaction which reveals that the high depth of processing group produced significantly more recall of the

critical items across the two levels of concreteness. Closer examination shows that the group with the highest depth of processing and the highest concreteness type of critical items had significantly more false recall of the critical items than the other three combinations. Also, it can be seen that as concreteness of the critical items increases, so does the number of recalled critical items. Simple effects were performed to examine where statistically significant differences occurred within this interaction. At the low concrete level the low and high depth of processing groups were not statistically different. However, at the high concrete level the two levels of processing were significantly different, $F (1, 236) = 27.98$, $p < .001$.

The other two way interactions of frequency by depth of processing and frequency by concreteness were both non-significant. The main effect of frequency was also non-significant.

The next analysis performed examined whether the groups differed in regard to their recall of accurate items. An analysis of variance was performed that examined depth of processing, concreteness and frequency on the number of accurate items recalled. The dependent variable was obtained by adding up the total number of items accurately recalled across all five lists.

No significant interactions were obtained from this analysis. However, the main effect of depth of processing was significant, $F (1, 232) = 26.48$, $p < .001$, $\eta^2 = .096$ as was concreteness, $F (1, 232) = 43.42$, $p < .001$, $\eta^2 = .152$. Frequency was once again not significant at the .05 level. The low depth of processing group recalled significantly fewer items overall then did the high processing group. The high concrete groups had the most items recalled relative to the low concrete groups. Figure 7 shows the main effect of

depth of processing for the total number of items accurately recalled. Figure 8 represents the main effects of concreteness on total items accurately recalled.

The second part of Experiment 1 examined reaction times in regard to the production of falsely recognized items. A 2 x 2 x 2 x 2 analysis of variance (Depth of processing x Word frequency x Concreteness x Type of word (accurate vs. critical items) was performed. No significant interactions were found. A significant main effect of word type (accurate versus critical item) for the repeated measure part of the design was found, F (1, 232) = 80.37, p = .000, η^2 = .258. The critical items were responded to significantly faster than the accurate items. Figure 9 presents the results of the main effect of word type on reaction times. The between-subjects main effect of depth of processing were also significant, F (1, 232) = 6.13, p = .000, η^2 = .030. It was found that the high depth of processing group was significantly faster in responding than the low depth of processing group. Figure 10 displays the mean reaction time for each depth of processing group.

The final analysis for Experiment 1 examined the recall of critical items versus the recognition of critical items. This analysis assessed whether participants differ in producing critical items (the recall condition) or in responding that they recognize the critical items. A mixed analysis of variance for memory type (recall vs. recognition) by depth of processing by concreteness by frequency was performed. The main effect of memory type was significant, F (1, 232) = 750.61, p < .001, η^2 = .764. Figure 11 shows the proportion of items recalled versus recognized across all variables.

The interaction of memory type and depth of processing was also significant, F (1, 232) = 23.09, p < .001, η^2 = .091. Figure 12 displays the interaction between depth of

processing and memory type on proportion of critical items recalled. Simple effects

analysis showed that there were significantly more recalled critical items in the high

depth of processing condition than the low condition, F (1, 238) = 17.12, p < .001. At the

recognition level the two processing conditions did not differ significantly. Overall, the

recognition condition had higher proportion of critical items than the recall condition.

The results also produced a significant two way interaction between memory type

and concreteness, F (1, 232) = 29.16, p < .001, η^2 = .112. Simple effects analysis

revealed that at the recognition level the two levels of concreteness did not differ

significantly. However, at the recall level the high concrete items had a significantly

higher mean proportion of critical items than the low concrete items, F (1, 238) = 64.71,

p < .001. Figure 13 shows the interaction of memory type with concreteness on

proportion of critical items recalled.

The between-subjects portion of the analysis also revealed some statistically

significant results. Once again, the only main effects found to be significant were depth

of processing, F (1, 232) = 7.50, p = .007, η^2 = .031 and concreteness, F (1, 232) = 60.28,

p = .000, η^2 = .210. Figure 14 shows the main effect of depth of processing on the mean

proportion of recalled and recognized critical items combined. Figure 15 shows that the

high concrete critical items had the highest mean proportion recalled and recognized.

The highest order interaction obtained was depth of processing by concreteness, F

(1, 232) = 6.09, p < .01, η^2 = .026. This interaction was produced by collapsing across the

repeated measures variable of memory type (recall and recognition). Simple effects were

performed to examine where the differences were located. It was found that the levels of

concreteness were significantly different at the low processing level, F (1, 236) = 13.99, p

$< .001$ and at the high processing condition, $F (1, 236) = 52.24$, $p < .001$. Figure 16

illustrates this interaction between concreteness and depth of processing on mean

proportion both recalled and recognized.
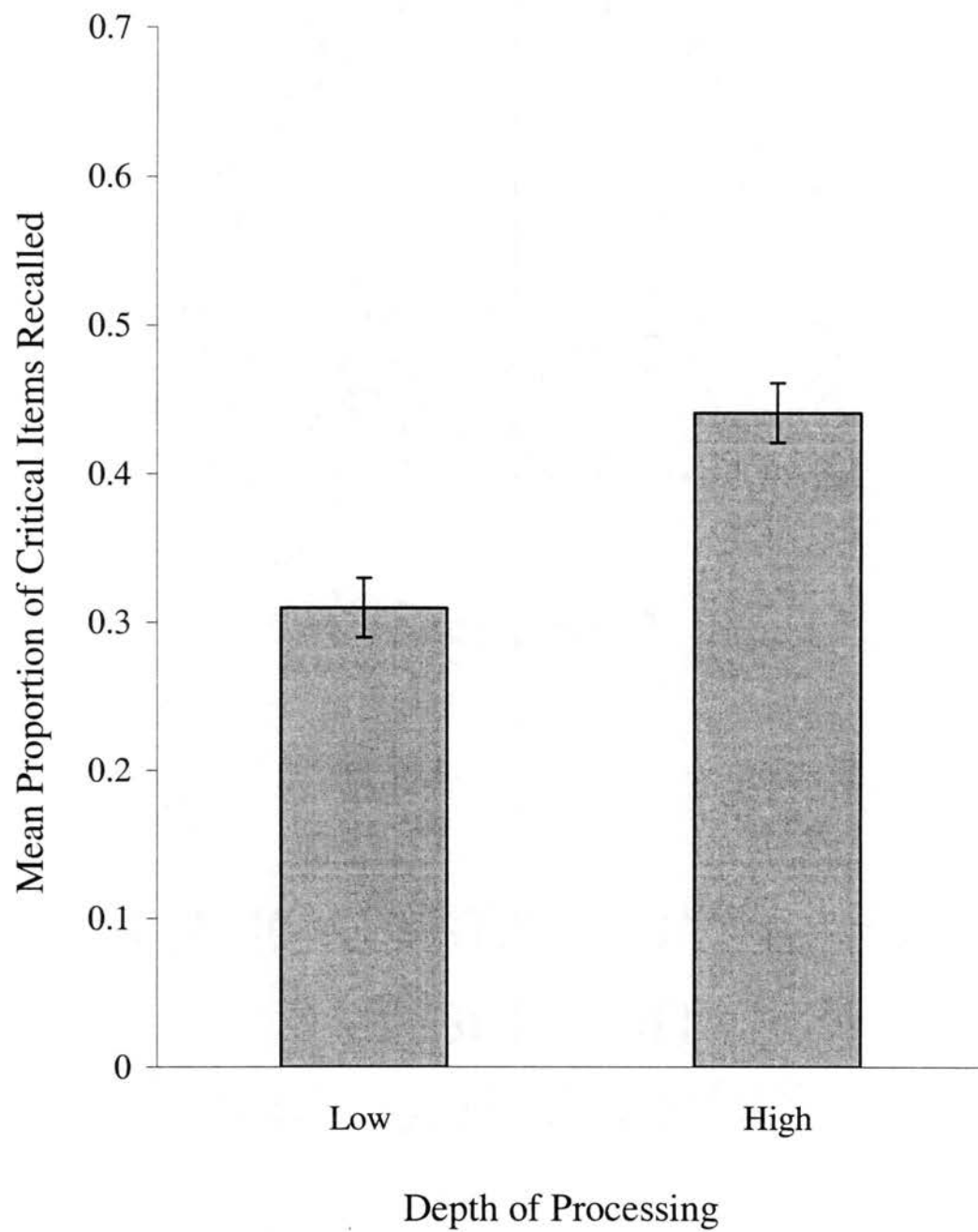
Figure 4. Main effect of depth of processing on mean proportion of critical items

recalled. Error bars are the standard error of the means.
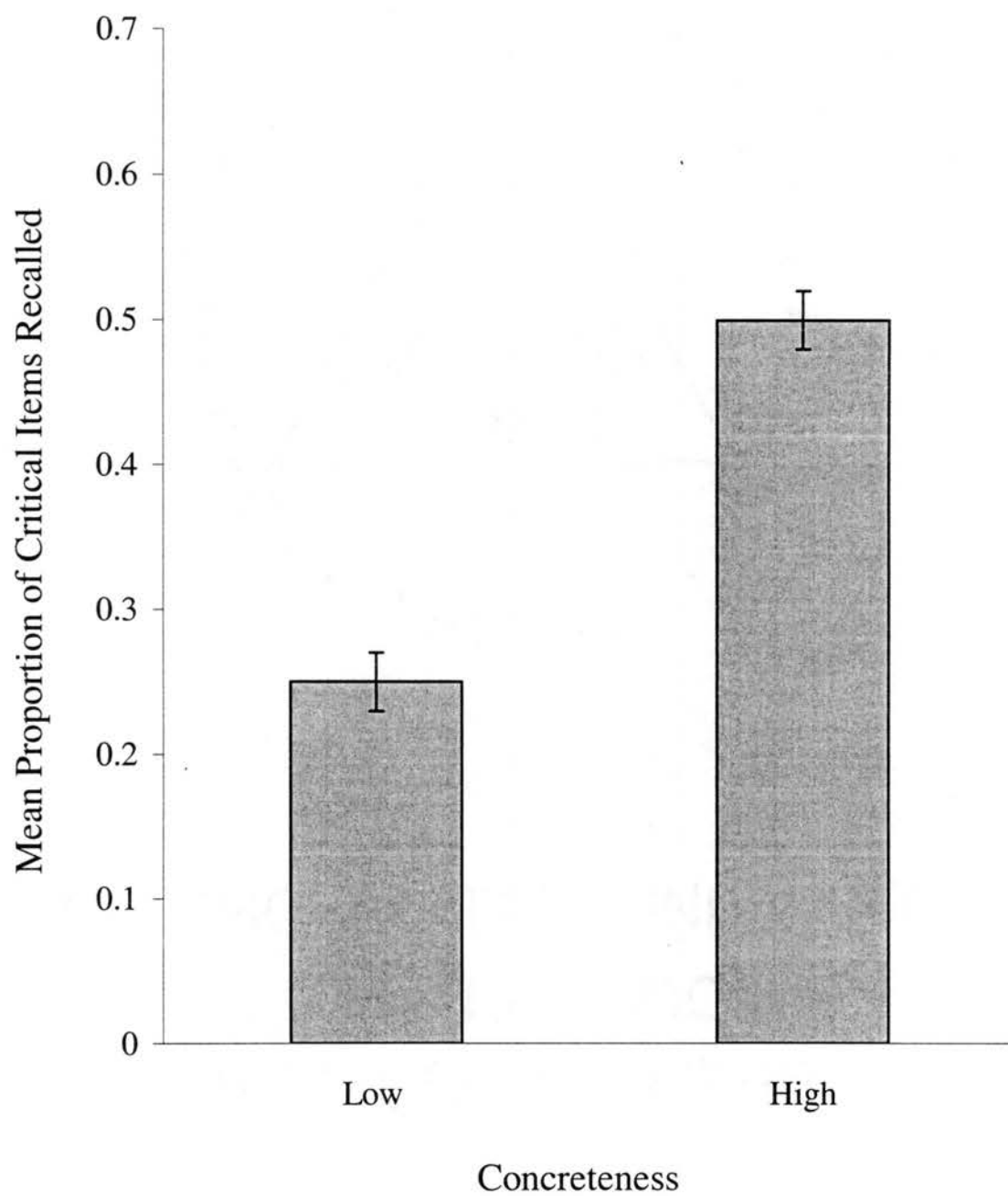
Figure 5. Concreteness main effect on mean proportion of critical items recalled
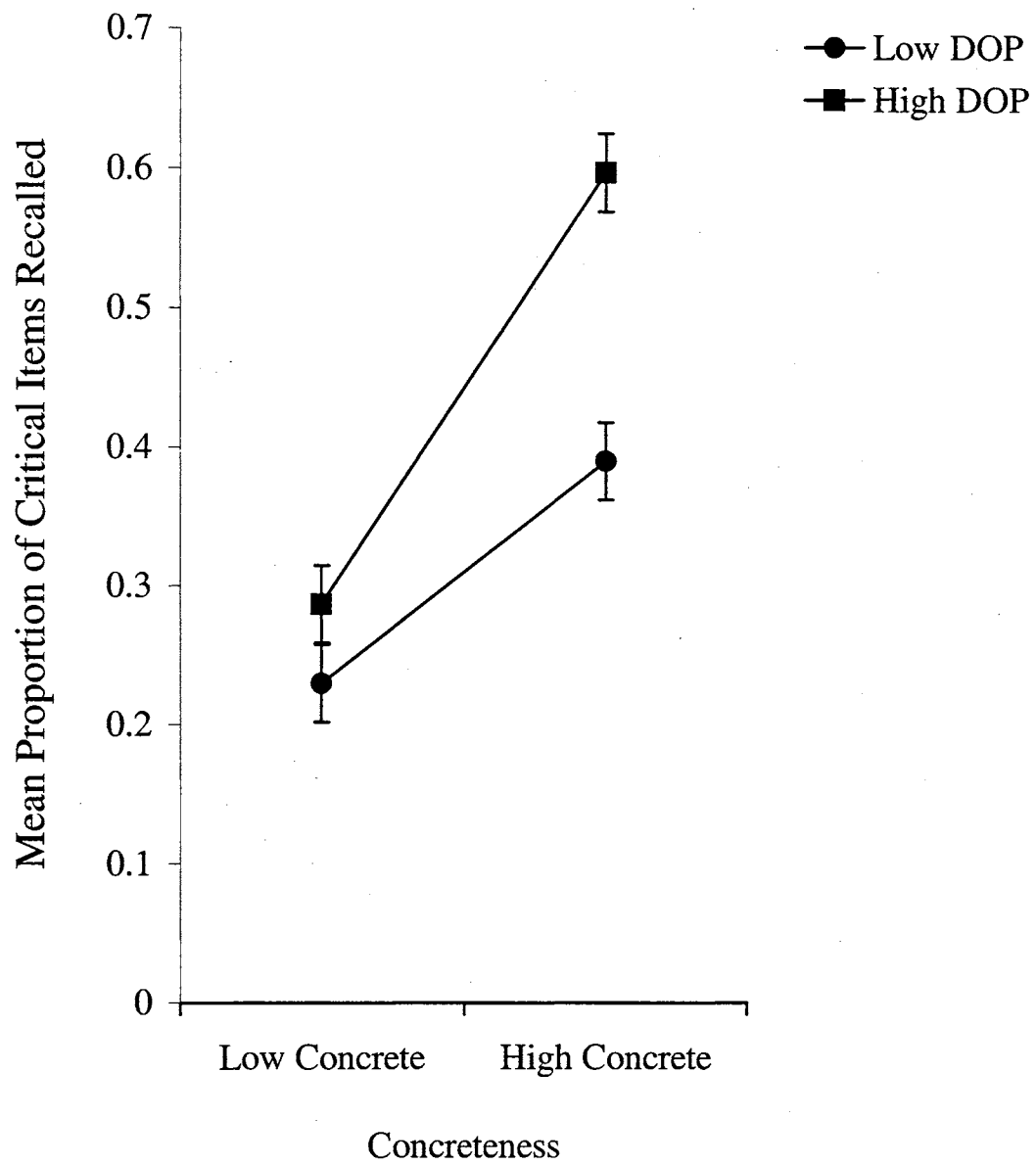
Figure 6. Interaction graph of concreteness by depth of processing.
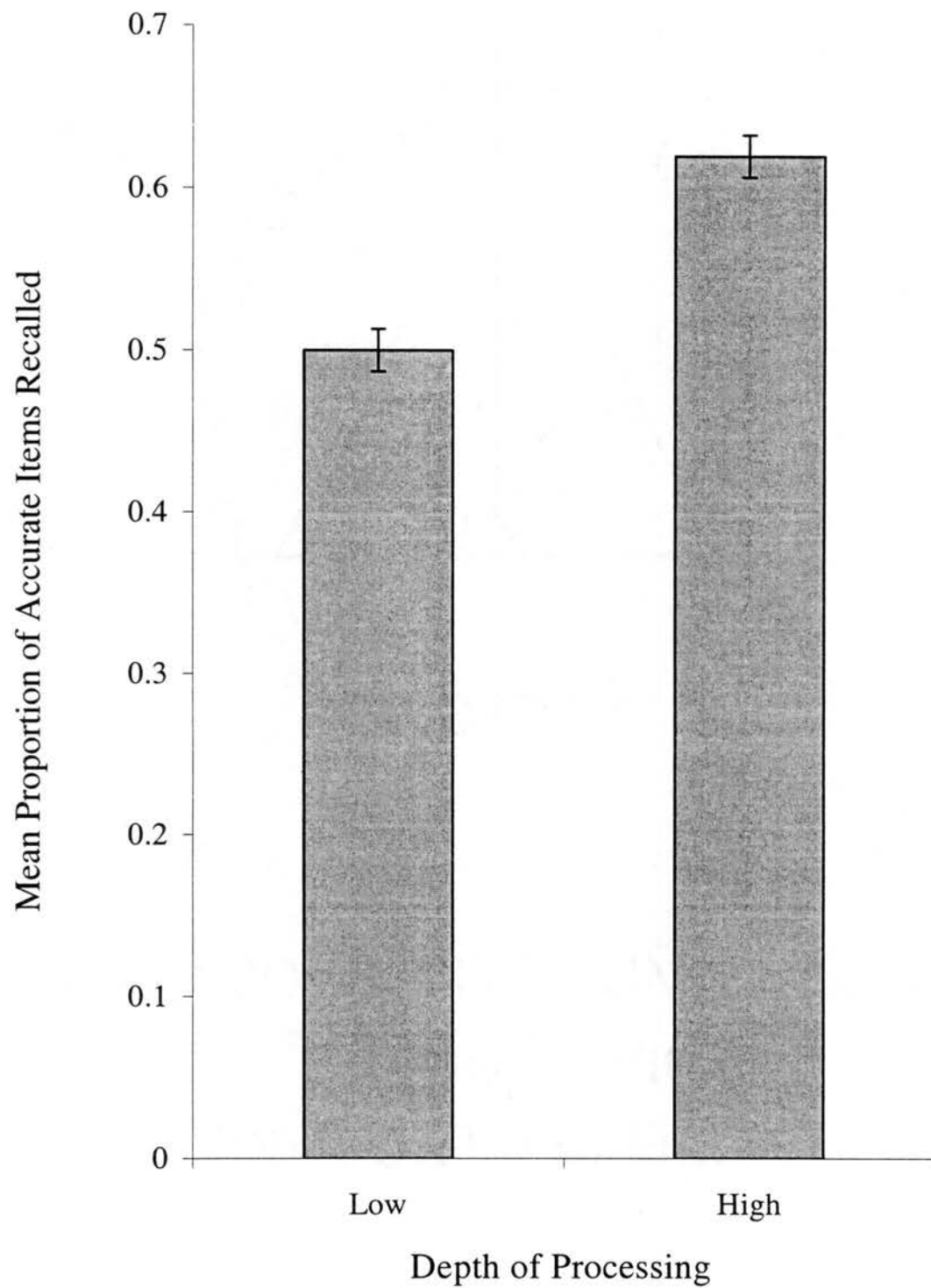
Figure 7. Main effect of depth of processing on total number of accurately items recalled.
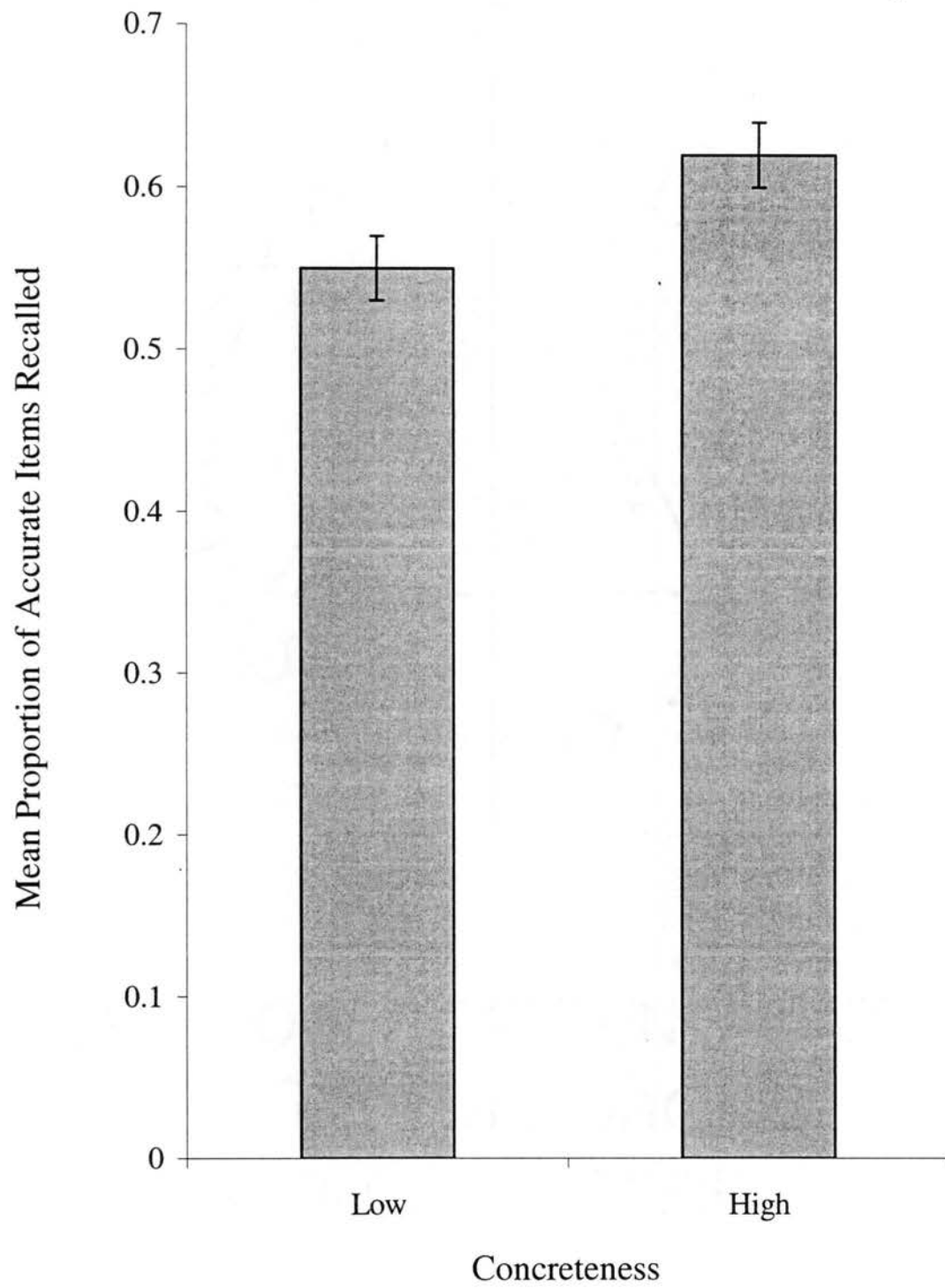
Figure 8. Concreteness main effect on total number of items accurately recalled.
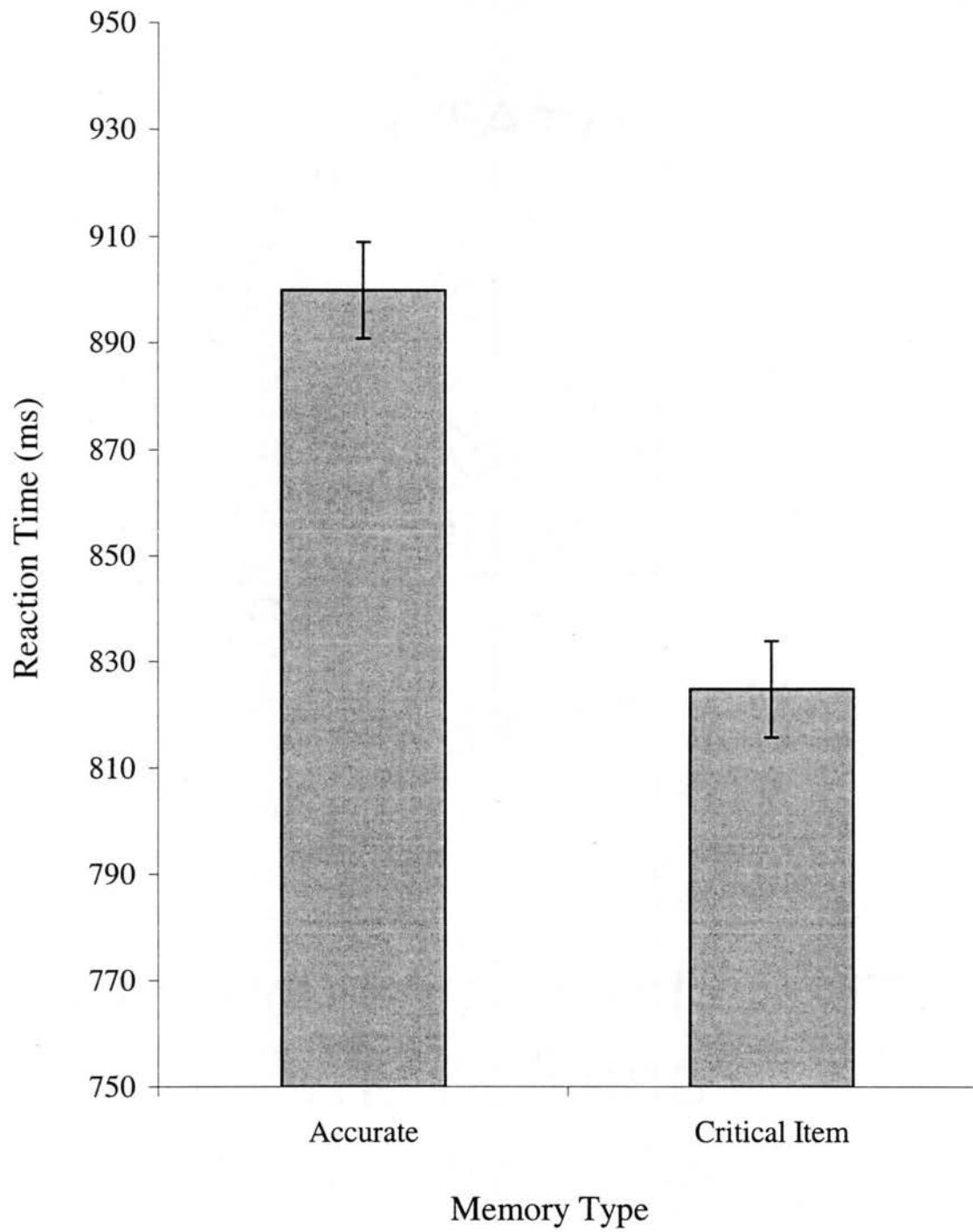
Figure 9. Main effect of reaction times across all groups for each type of word recognized.
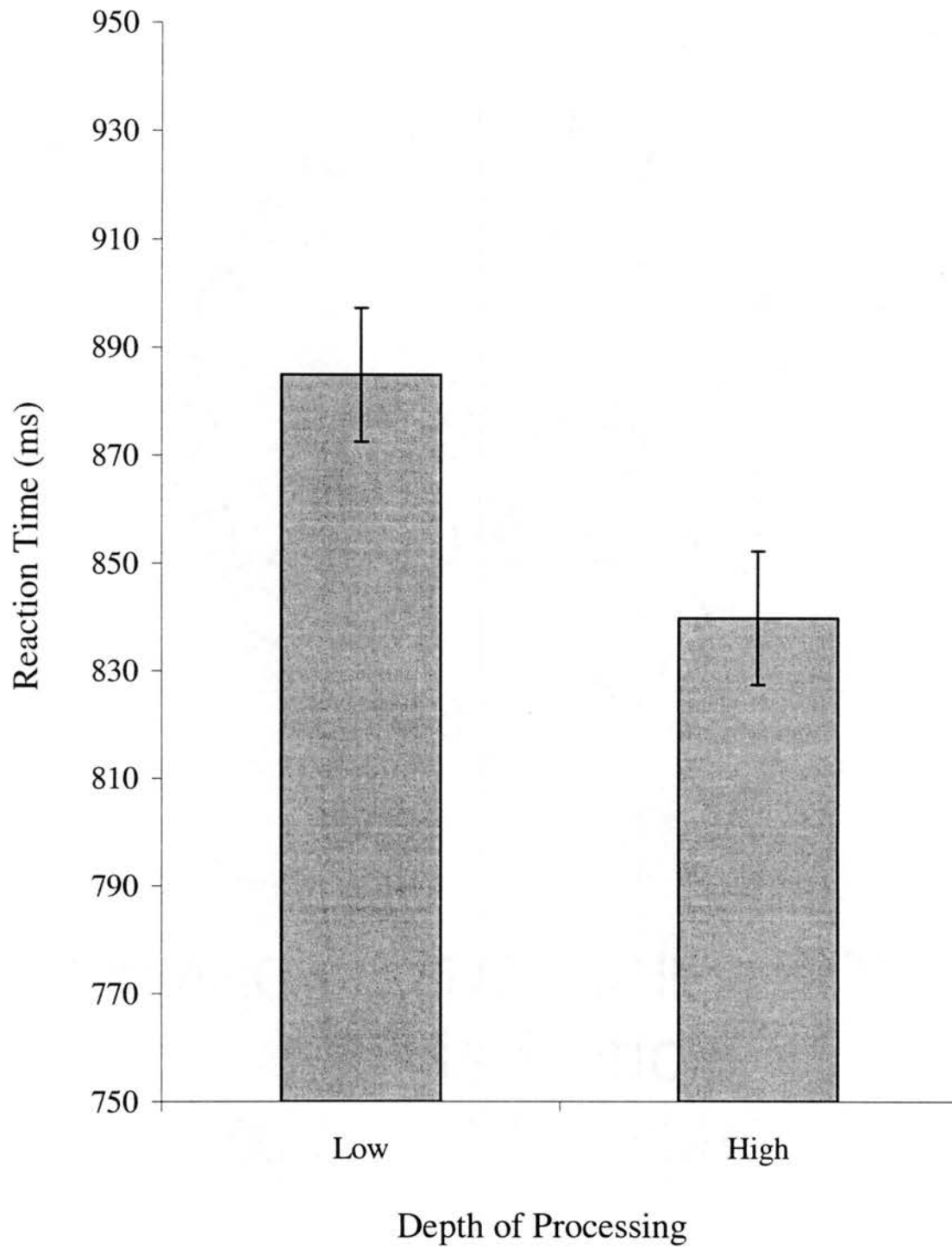
Figure 10. Main effect of depth of processing reaction times across concreteness and

frequency variables.
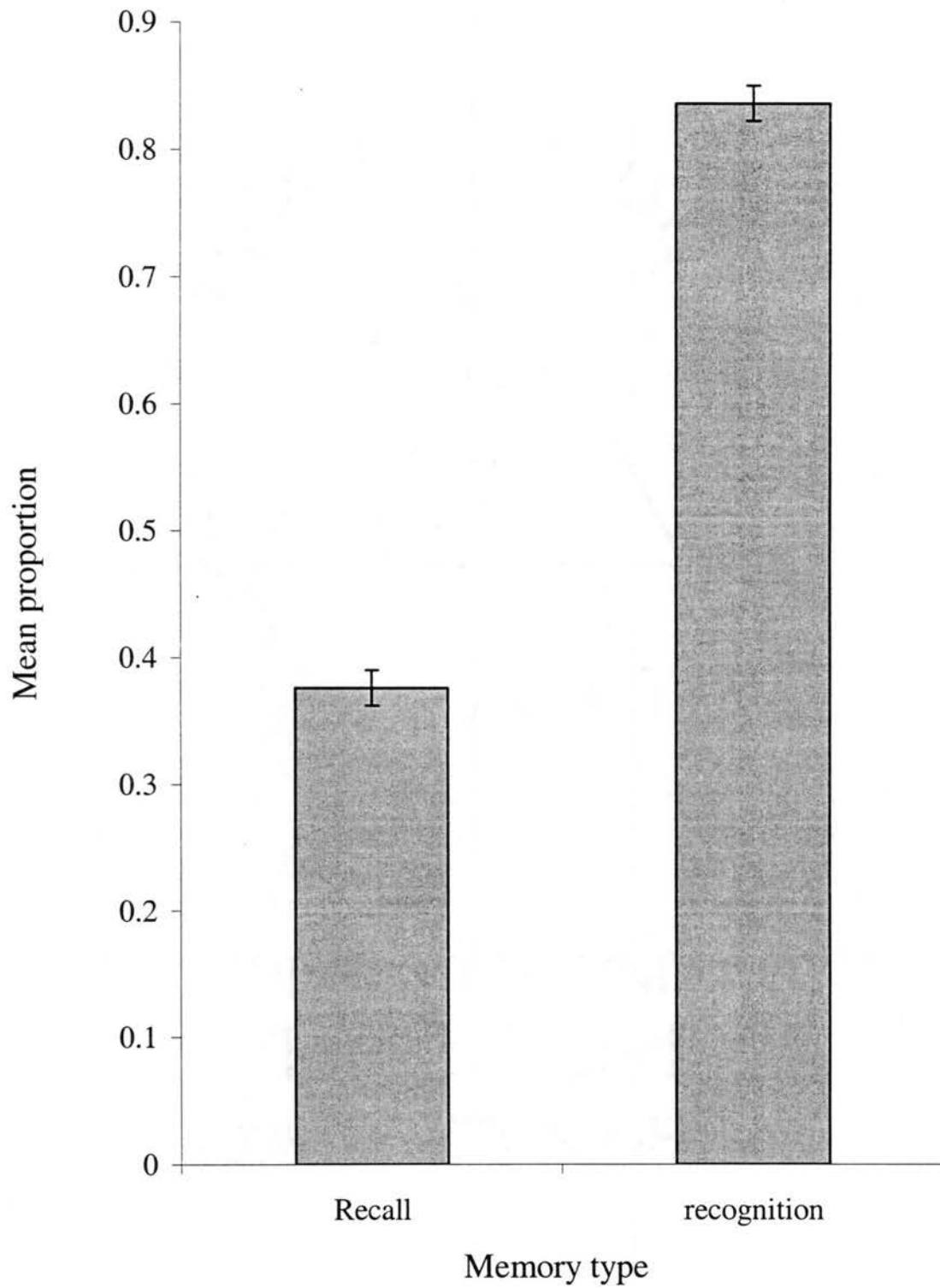
Figure 11. Mean proportion of critical items recognized versus recalled.
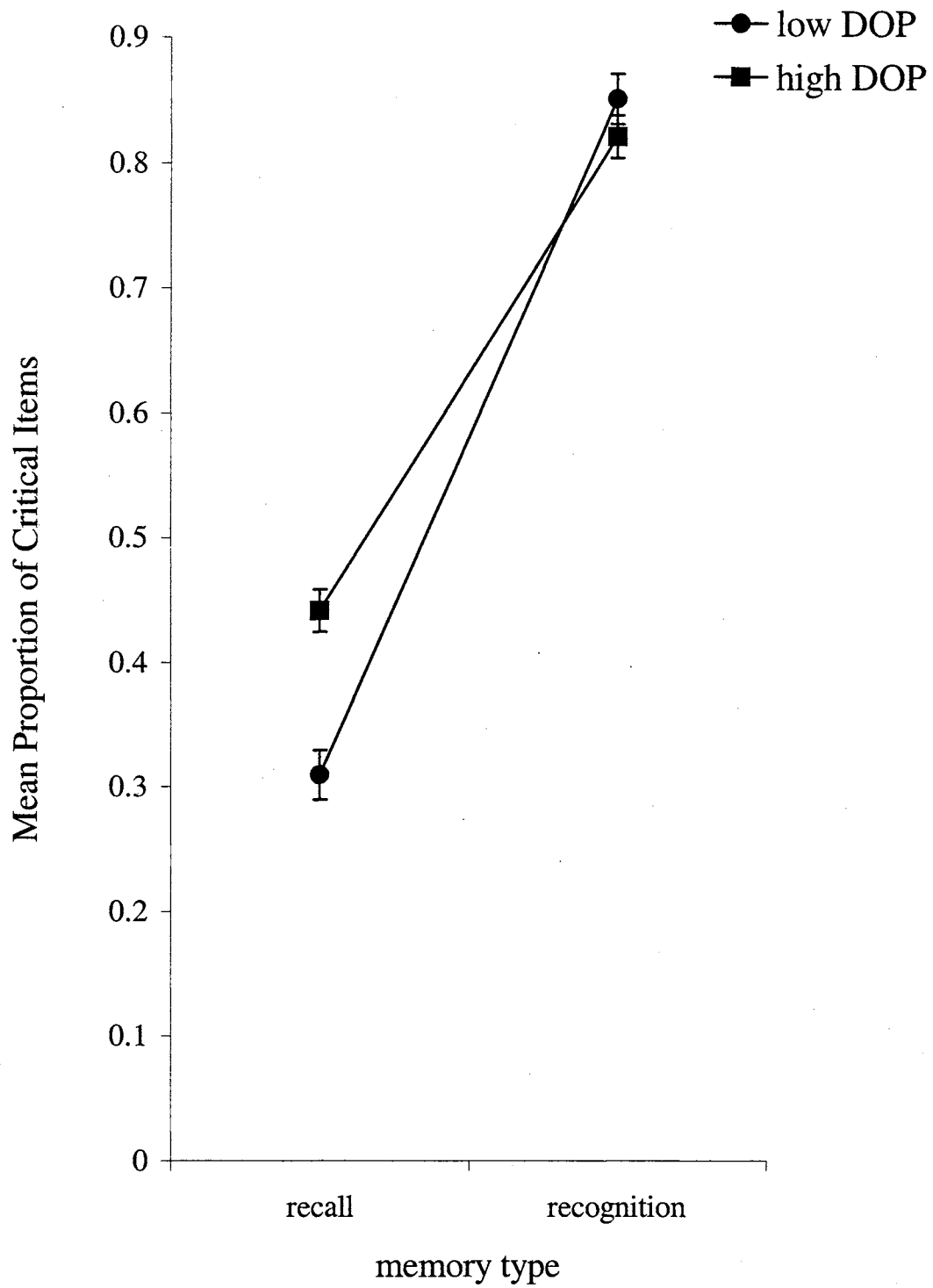
Figure 12. Interaction of Depth of processing with memory type (Recall vs Recognition)
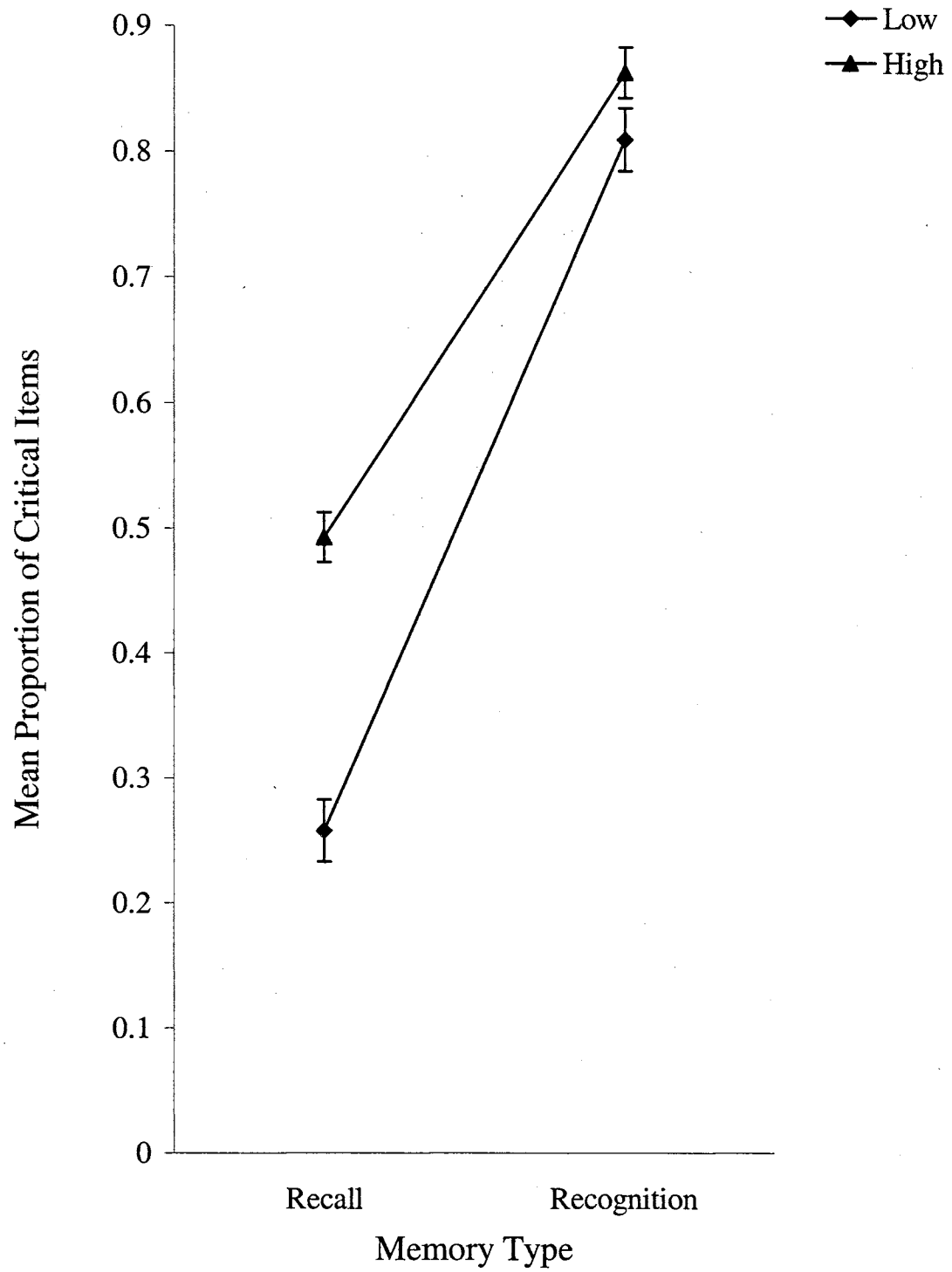
Figure 13. Interaction between concreteness and memory type.
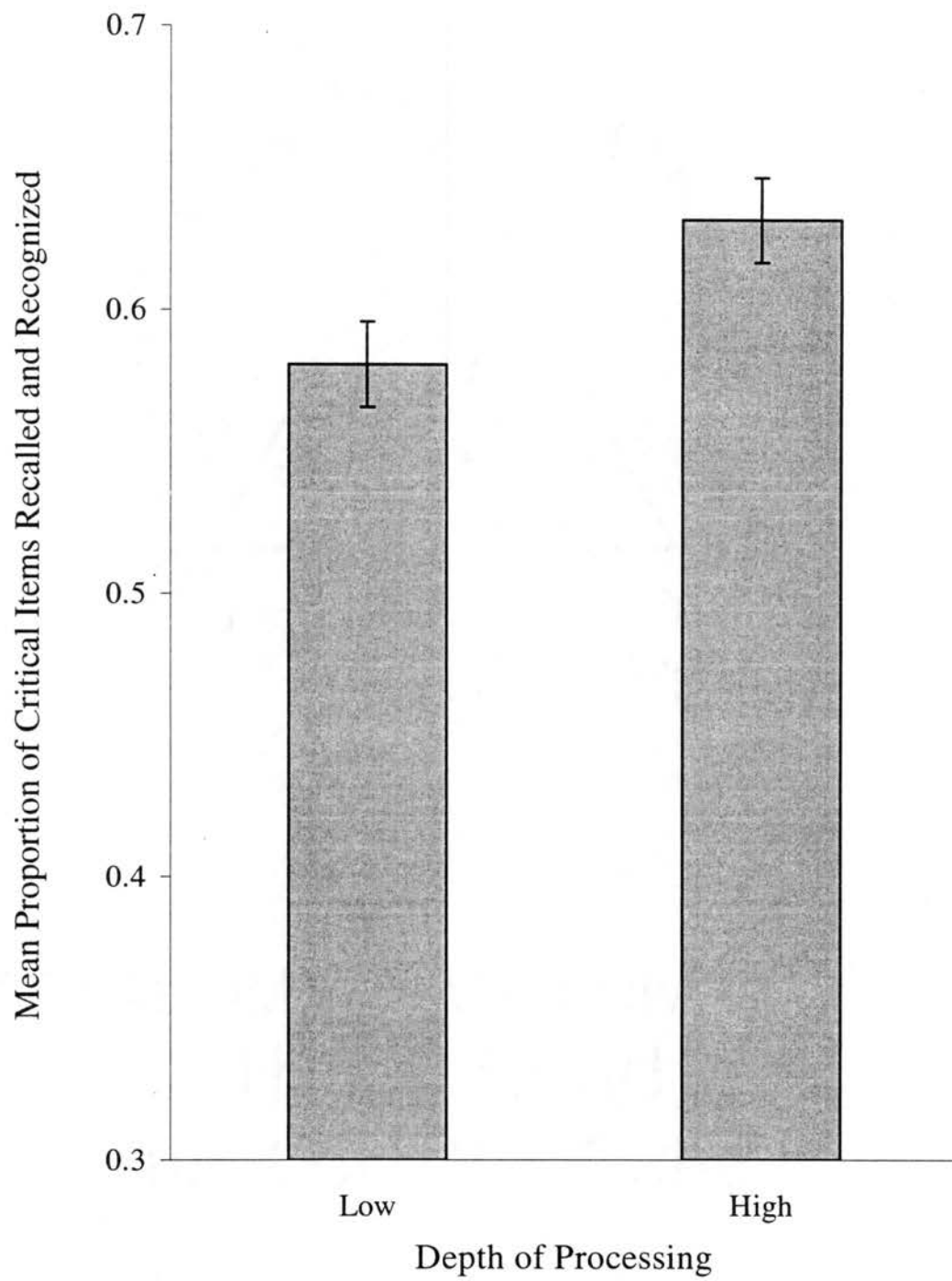
Figure 14. Depth of processing main affect across recall and recognition memory.
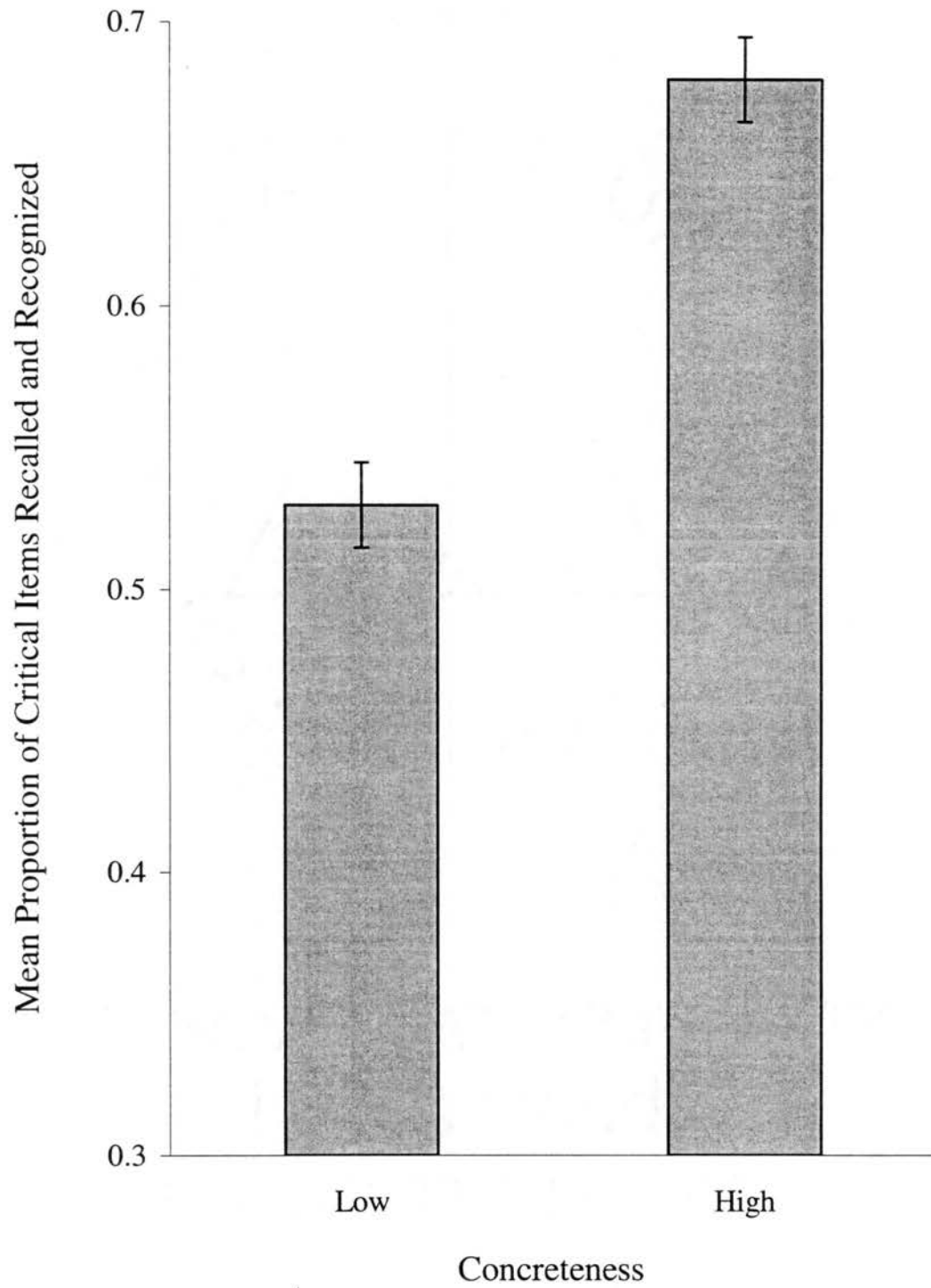
Figure 15. Concreteness main effect across recall and recognition memory.
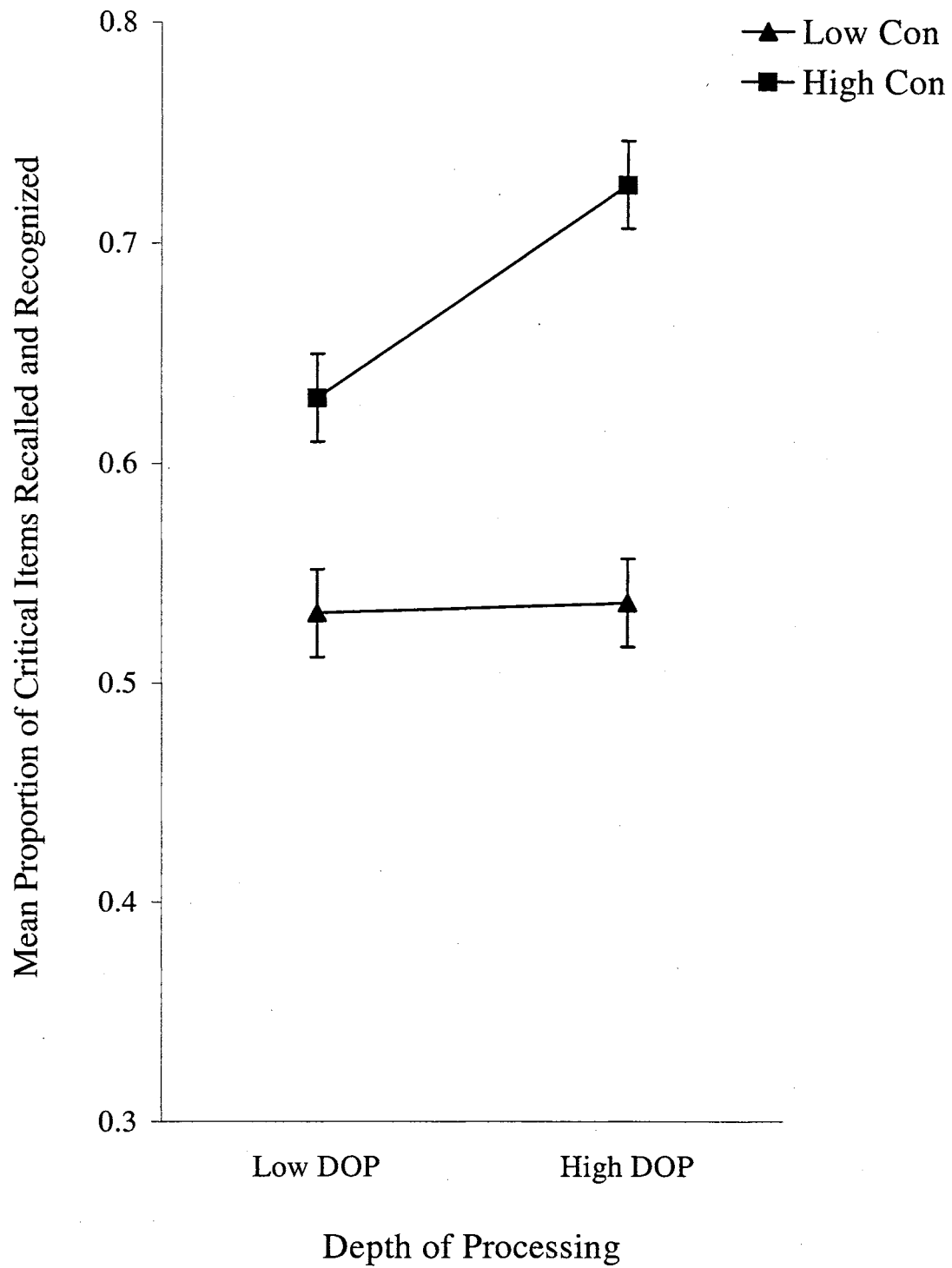
Figure 16. Interaction of depth of processing with concreteness for recall and recognition

memory combined.

Experiment 2.

Experiment 2 examined depressed subjects as defined by their Beck Depression Inventory scores. The depressed participants were matched with control participants from Experiment 1. They were matched by gender and the group that they were assigned to with an equal number of participants who scored a five or less on the BDI. A total of 16 participants were obtained during data collection for Experiment 1 with scores of 17 or higher on the BDI and were then classified as depressed. The range of BDI scores was 17 to 30.

The average BDI score for the depressed group was 20.4 and 1.6 for the non-depressed. Within each group there were nine men and seven women. Since these participants were not evenly distributed for each condition, analyses were only performed to examine how they differentially responded to the critical items as well as reaction time performance.

The first analysis performed was a 2 (depressed; non-depressed) x 2 (accurate; critical item) analysis of variance on the mean proportion of items recalled. There was no significant interaction obtained. The main effect of group was significant, $F (1, 30) = 9.912, p < .001$. Since the theoretical question was to examine how the groups differ for each type of word, t-tests were used to assess these differences for each group.

First, a t-test was performed on the group (depressed/non depressed) variable for proportion of critical items recalled. A significant effect was found between the depressed and non depressed groups, $t (30) = 2.82, p < .05$. Figure 17 shows that the depressed group produced significantly fewer critical items then did the control group.

The next analysis focused on the number of items correctly recalled between the two groups. An independent samples t-test was performed between the depressed group and non depressed group. A marginally significant difference for group was obtained, t (30) = 2.01, p = .054. This analysis was performed to assess how the groups responded overall. Figure 18 shows the accuracy data for the groups.

Further analysis on the proportion of accurate items and critical items that were recognized was examined. A mixed 2 (accurate, critical item) x 2 (depress, non-depressed) analysis of variance was performed. The results revealed a significant interaction between the word type and group variables, F (1, 30) = 4.94, p < .05. Post hoc analysis examining the interaction found that the groups differed significantly only for the critical items, F (1, 30) = 5.78, p < .05. All other comparisons were non significant. Figure 19 presents this interaction between type of word recognized by group.

The next area examined was to determine if the groups differed based on reaction time for the critical items. A t-test was performed to assess if the two groups differed significantly in reaction time. The results indicated that the depressed group was significantly slower in responding than the non depressed group, t (30) = 4.05, p < .001. Figure 20 shows that the depressed group had significantly slower reaction times than did the control group.

Further analysis examined how the groups differed in regard to reaction times for recognition of accurate items versus recognition of critical items. A repeated measures analysis of variance was performed with type of word being the repeated measure between the two levels of group. A significant interaction between word type and group

was obtained, $F(1, 30) = 5.10$, $p < .05$, $\eta^2 = .145$. Simple effects examined where the significant differences were located. It was found that at the accurate word level the depressed groups reaction times were significantly slower than the non depressed group, $F(1, 30) = 10.53$, $p < .05$. Also, the depressed group was significantly slower in responding to the critical items than the control group, $F(1,30) = 16.36$, $p < .001$. Further post hoc analysis of the within part of the interaction showed that the depressed group did not differ significantly between the accurate and critical items reaction times, $t(15) = -.640$, n.s. However, the non-depressed groups reaction times were significantly faster for the critical items than for the accurate items, $t(15) = 4.70$, $p < .001$. Figure 21 shows this interaction between word type and group.

Additional analysis revealed that the word main effect was not significant. This may be caused by having the words collapsed across groups, the means become very similar; 881 ms for accurate versus 848 ms for critical items. However, the main effect of the group variable was found to be significant, $F(1, 30) = 18.24$, $p = .000$, $\eta^2 = .378$. The depressed group was significantly slower for both accurate and critical items combined in comparison to the non depressed group. The depressed group responded more slowly relative to the non depressed groups across both words. The depressed group's reaction times were 954 ms for the accurate words and 992 ms for the critical items. This effect is opposite to that of the non depressed group who performed much faster on the critical items (705 ms) than the accurate items (808 ms). Figure 22 shows the main effect of group and how much slower overall the depressed participants responded to the stimuli.
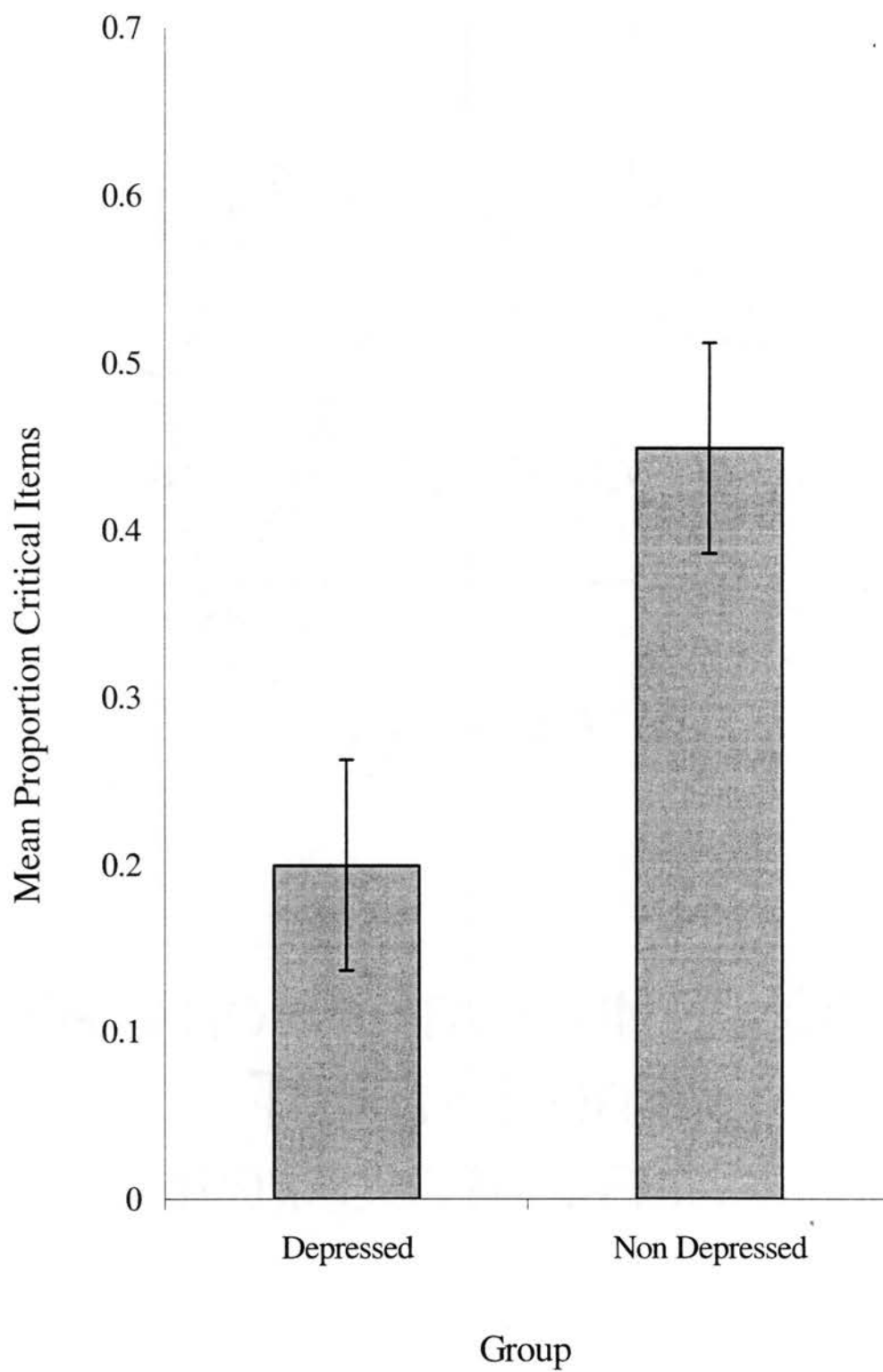
Figure 17. Depressed vs. non depressed on number of critical items recalled.
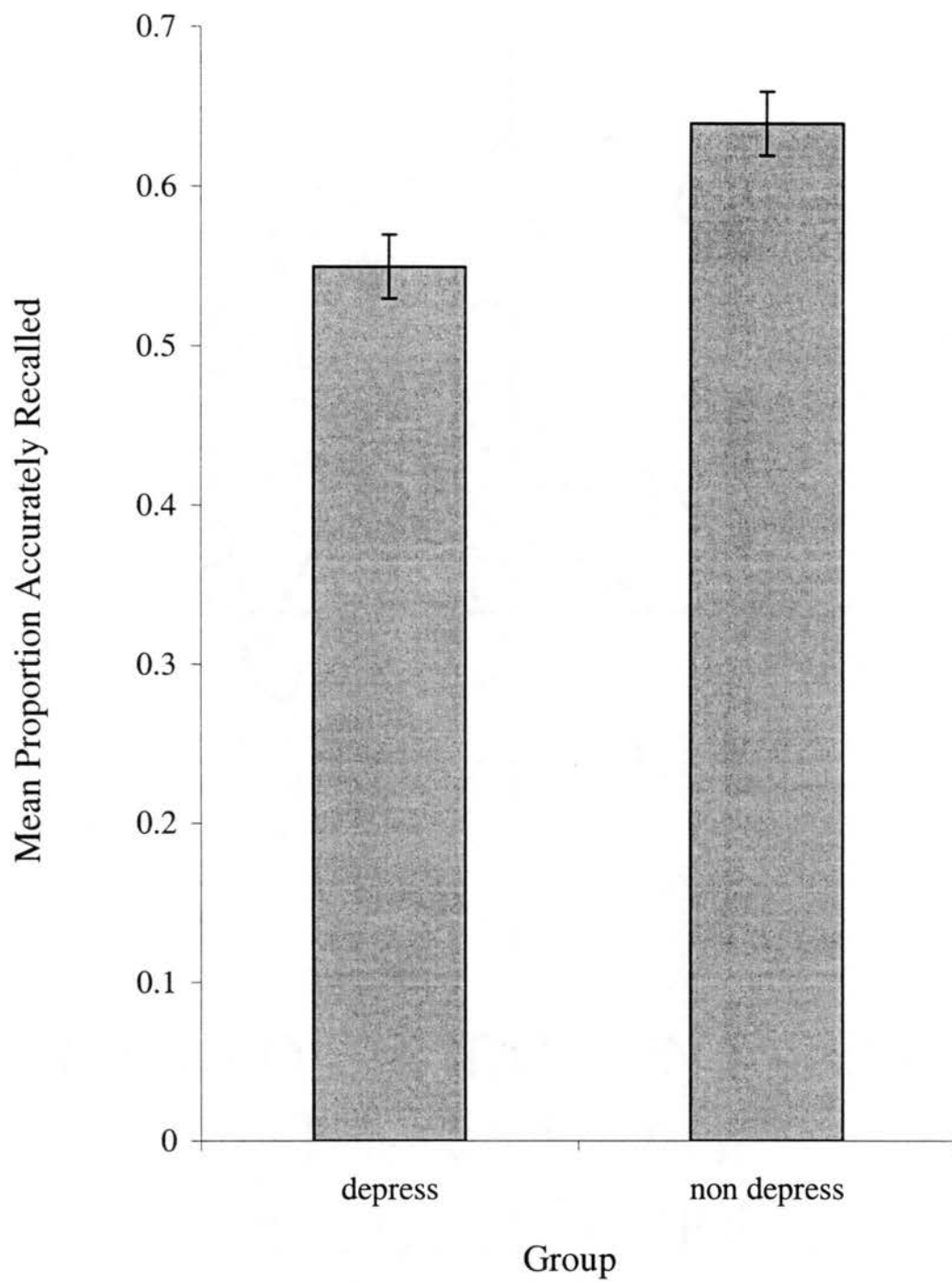
Figure 18. Depress vs. non depressed groups on accurate items recalled.
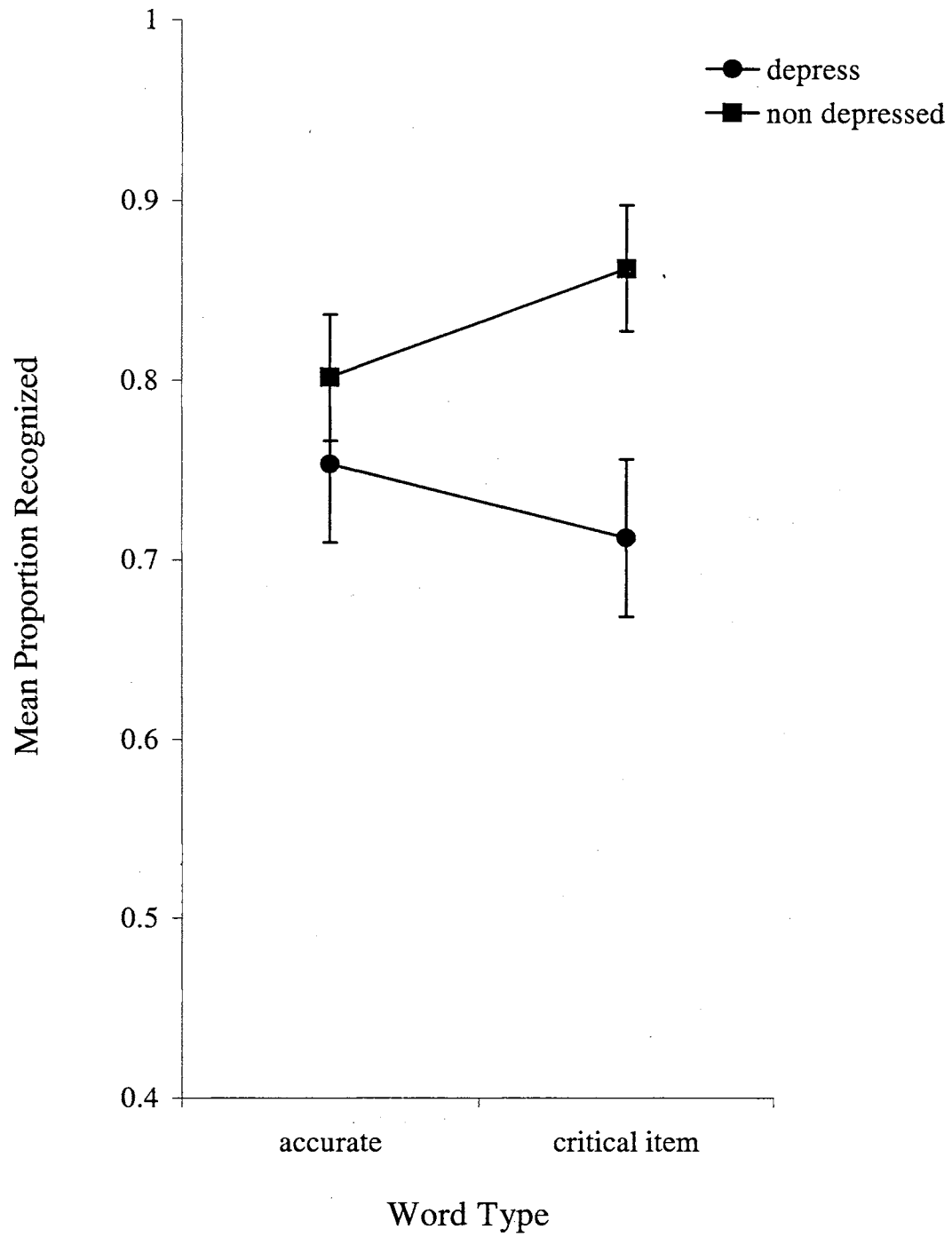
Figure 19. Depress vs. non-depressed groups on mean proportion of accurate and critical items recognized.
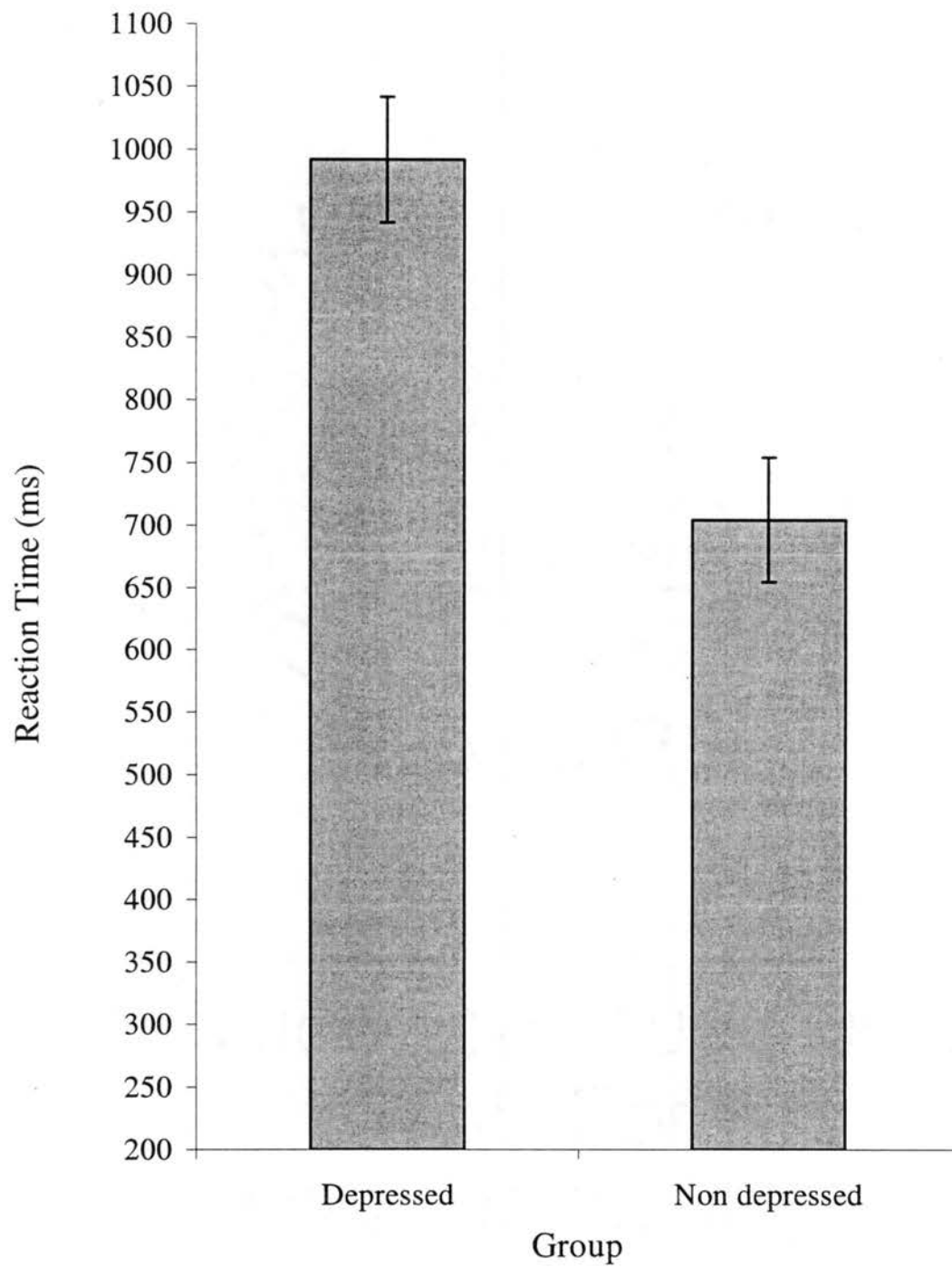
Figure 20. Reaction times for depressed versus non depressed on critical items.
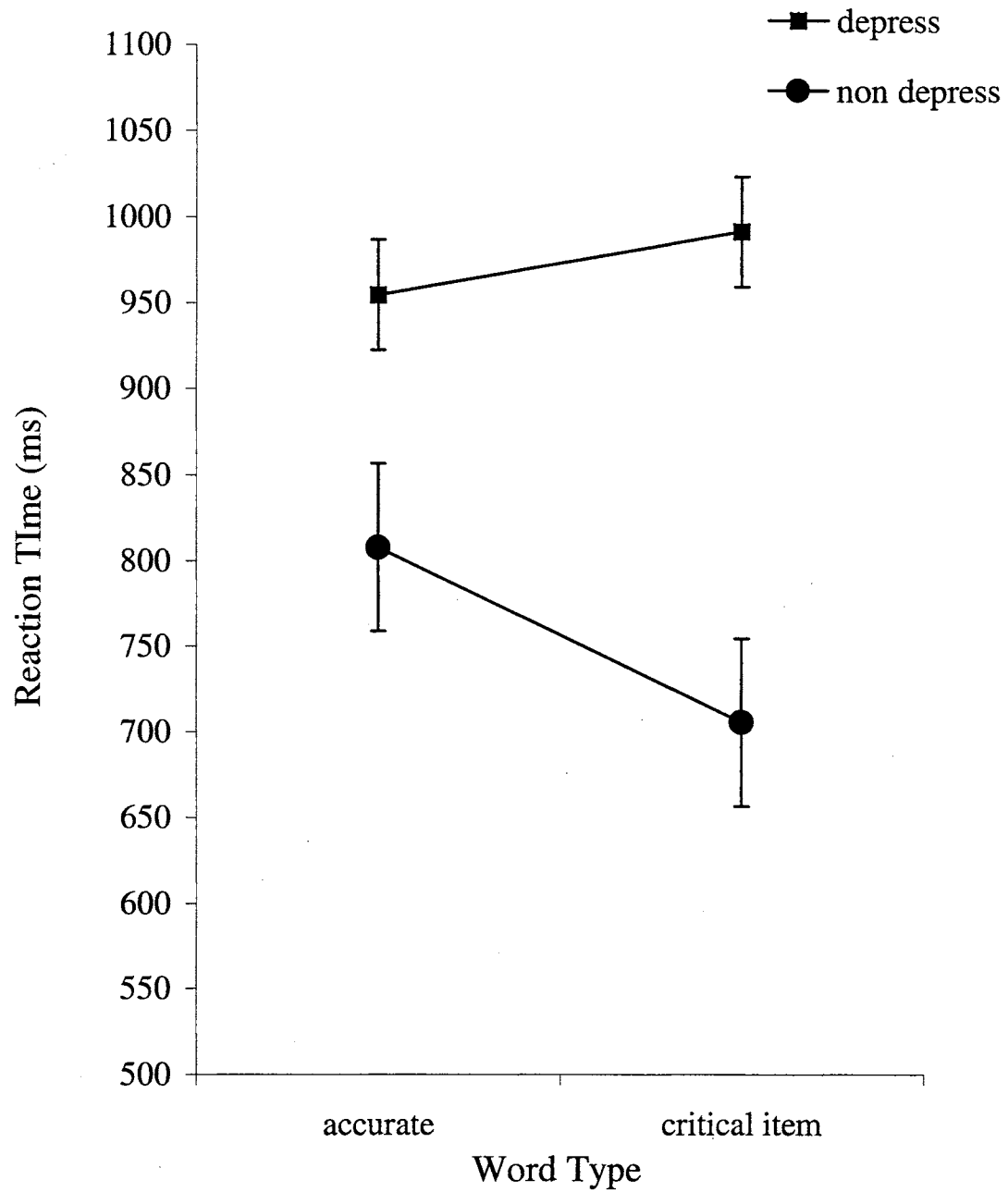
Figure 21. Interaction graph for Word type and Group on reaction times.
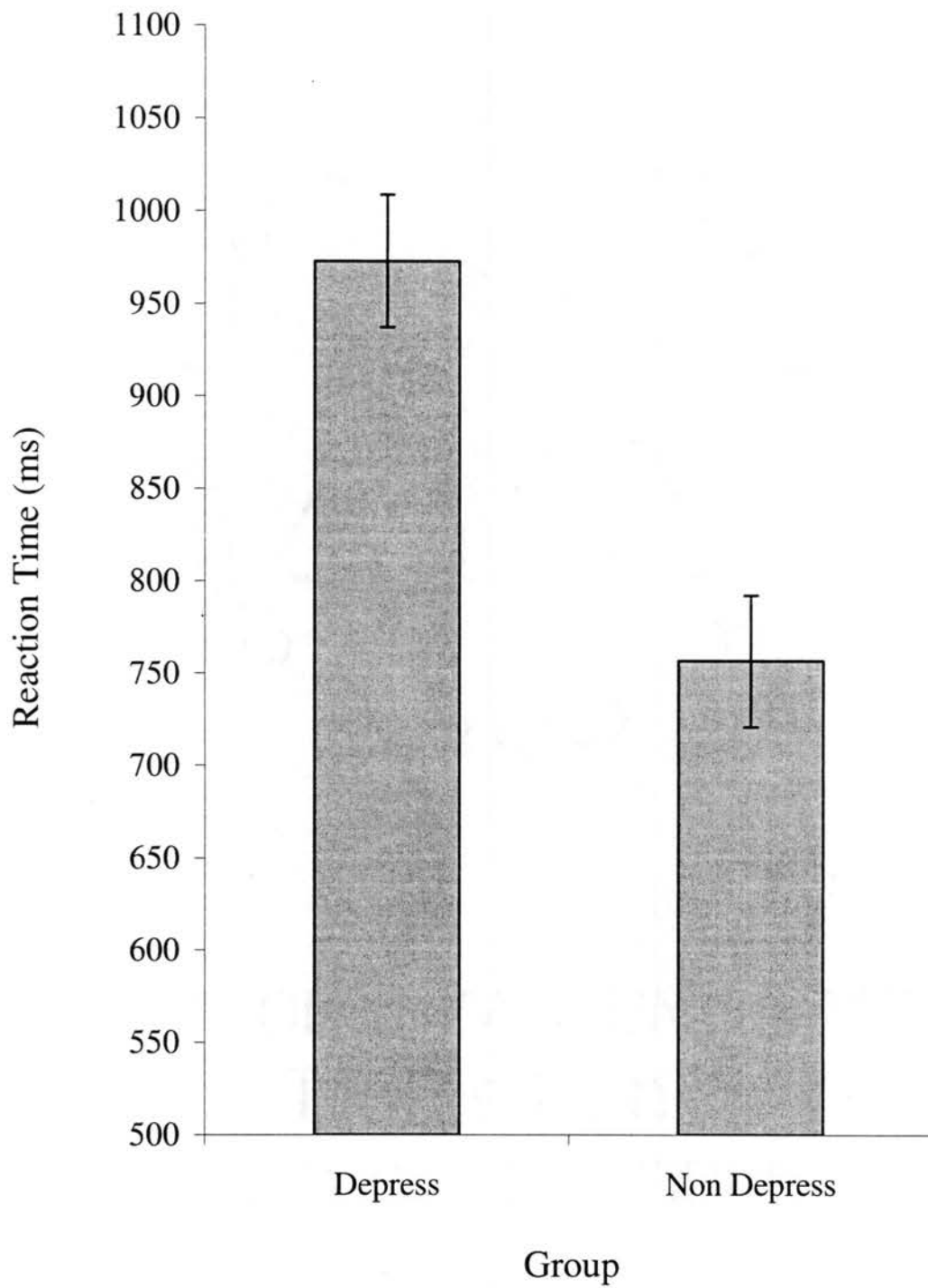
Figure 22. Main effect of group for reaction times on both CI and Accurate words.

CHAPTER VI

DISCUSSION

The focus of Experiment 1 and 2 examined whether word frequency, concreteness and depth of processing significantly affected the production of the critical items. Critical items are the words that were never presented to the participants. It was predicted that each of the variables would play a significant role in the recall of the critical items. It was also expected that the variables should interact in some way and that the interpretation of these interactions would help explain how the combination of these variables produced the critical items.

The results obtained indicated that there were interactions but not all three variables were significantly involved. The frequency variable did not contribute to the variability in the production of the critical items. This variable had been expected to influence recall of the critical items since the more frequently occurring the critical item is, the easier it is to be semantically activated and recalled. The main effect means for frequency were very similar for low and high frequency which indicates that this was not a significant source of variance.

Whereas the frequency factor was non-significant, the concrete and depth of processing variables were significant. It was expected that depth of processing would play a significant role in the recall of the critical items. Previous research has shown that increasing processing will not only increase overall recall but also may increase the likelihood of the generation of the critical items (Roediger & McDermott, 2000). Examining the main effect of depth of processing shows a clear and significantly higher production of critical items for the high depth of processing group. This variable also

interacted with the concreteness variable as well in generating the number of critical items recalled. The main effect of concreteness revealed that the high concrete group had significantly more recall of critical items.

Since there was a significant interaction between the concreteness and depth of processing variables one must examine the interaction to explain this effect since the main effects by themselves are subsumed within this interaction. The main effects can be used to provide information as to how much variability each variable produced. Also, this experiment focused on how each variable affected the production of critical items so the main effects are useful to examine for this experiment.

The interaction revealed that the high depth of processing group had significantly more recall of critical items across both concreteness conditions than did the low depth of processing group. Further, the difference between the low and high depth of processing groups was most prominent at the high concrete level. This would indicate that not only is depth of processing very important in recall but concreteness of the item differentially influences the recall of critical items significantly more at the high concrete level than at the low concrete level.

Another interesting result found from this analysis was the significant interaction obtained between the depth of processing and concreteness groups across both types of memory. The low concrete items had less overall proportion of critical items recalled and recognized then the high concrete group. Further the low concrete groups did not differ between low and high depth of processing. For the high concreteness groups, there was a significant increase of responding at the high processing level. This may have been caused by the fact that not only were participants in this condition able to process the

information more deeply, the critical items themselves were also highly concrete which increased both rates of recall and recognition. The overall main effects of depth of processing and concreteness support the idea that each of these variables influence the recall and recognition of the critical items.

Another analysis was performed to examine the number of items accurately recalled. The results indicated significant differences between the low and high depth of processing groups as expected. This analysis could also be viewed as a test of the experimental procedure. That is, participants who had the opportunity to rehearse the items in the high processing condition should have a significantly higher rate of recall overall in comparison the low depth of processing groups (Waugh & Norman, 1965).

The other factor was the influence of the concreteness of the item lists. The results indicate that the high concrete lists had significantly higher overall recall than did the low concrete lists. There were no significant interactions among the variables however. Even though significant differences were found the robustness of these findings based on the statistical analysis in regard to accurate items is somewhat lacking. This may be due to the fact that there were only 15 items in each list and that most participants had the ability to accurately recall most of those items so a ceiling effect may have occurred. The focus of this study was not general recall of accuracy however, but these statistics can be a useful tool to compare baseline responding among the groups.

Comparing the main effects for the critical items and the general recall of items shows that each variable affected the mean proportion recalled in a similar fashion. That is, the high depth of processing group outperformed the low depth of processing group for both the general recall of accurate items and the production of critical items. Also, the

concrete variable had the same pattern. The higher concrete lists had more accurate items recalled as well as having more critical items recalled.

The overall results of this part of the analysis indicates that concreteness has a more profound effect on both accurate recall and increasing the rate of critical item production. This may be the result that increasing the concreteness of the items allows one to better process the item since it is easier to imagine. Concreteness and imageability have been found to play a significant role in recall and the results from this study show that it influences the production of critical items as well (Paivio, Walsh & Bons, 1994). Depth of processing also plays a significant role in the production of critical items and in general recall as well. The conclusion from this is concreteness of the critical item plays a significant role in critical item recall and that word frequency is not as important. Also, the higher level of processing of the stimuli list, the more likely participants are to falsely recall items that were not presented. Moreover, based on previous literature of the impact that concreteness has on memory, it would be expected that concreteness would have a significant influence on memory for the critical items as well (Paivio, 1971). The results support this assumption and show that high concrete items are both recalled and recognized more than low concrete items. These results further support the idea that within the Deese- Roediger-McDermott paradigm, not only is associative strengths among the list items important but also the concreteness of the critical item.

The next hypothesis examined was whether reaction times differentiated between depth of processing groups and whether significant differences exist between the critical item and accurate items. The results did not produce any significant interactions but did produce a within-subjects effect for word type (accurate vs. critical item). The analysis

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indicated that the accurate items were responded to significantly slower when compared to the critical items. This was a surprising finding in that one would expect accurate items to be responded to more quickly since those items were actually presented to the participants. Previous research has shown that reaction times tend to be faster for items that were previously presented since these items were most recently activated (Silverman, 1985). However, the critical items were responded to almost 100 milliseconds quicker than the accurate items. This may have been caused by the items in the list being strongly associated with the critical item causing the critical item to become activated during list presentation. From this repeated activation, the critical items were responded to faster than the regular items.

The interaction of concrete, frequency and depth of processing did not produce any significant results. For the between-subjects portion of the analyses the depth of processing group did produce a significant main effect. This finding supported the hypothesis that the more processing performed, the faster one is able to respond to the stimulus items. For this analysis only the depth of processing variable was significant on reaction times. Neither the concrete nor frequency variable differed significantly alone or in an interaction for reaction times. This may have been due to the fact that the average reaction times for response were all very similar and the variables under study did not lead to any significant changes in response rate.

The next hypothesis tested was that there should be significantly higher rates of falsely recalled items for the recognition task than the free recall task. The results from Experiment 1 support the hypothesis that there would be significantly more critical items recognized than recalled. The results clearly show this effect. The main effect of memory

type indicated that recall had significantly less production of critical items than recognition memory. This is based on the assumption that to freely recall the critical items these items must have been activated in some way during the presentation of the word list. If the critical item was not strongly activated during encoding then it is unlikely for it to be freely recalled. However, in the recognition phase, the participant is presented with the critical item and asked whether they remember it or not. Even if that critical item had only been activated slightly it may be enough for the participant to think that they in fact had been presented with that item.

The depth of processing and memory type interaction provided further support that the type of memory for critical items was due in part to the amount of processing that occurred. The high depth of processing groups produced significantly more critical items for the recall condition than the low depth of processing groups. For recognition memory both groups had about identical rates for recognition of the critical items. The reason for this is possibly that all subjects had the critical items activated as each list was presented and all participants responded that they recognized the critical item.

It was expected that the low depth of processing group should have had less recognition of the critical items since they were not given the opportunity to rehearse as deeply. These results indicate that participants were able to process the lists enough to activate the critical item. Future research could examine at what point does processing activate the critical item and attempt to find if not being able to process the information will cause the participants to not recognize the critical items. This could be done by having the participant perform a very complex task during the presentation of the stimulus items so that they are not able to attend or process the items very deeply.

Experiment 2

The results from Experiment 2 support the hypothesis that depressed and non-depressed groups differ in regard to the number of false memories and overall accuracy. Also, that the groups differ in reaction time to the test stimuli. The first analysis performed clearly shows that depressed individuals freely recall significantly fewer critical items than the non- depressed group. This follows the idea that depressed individuals do not process information as globally as non-depressed. That is, depressed participants focus only on the items presented and do not have as much activation of related concepts or items such as critical items.

The results also indicated that the depressed group had fewer accurate items recalled overall than the control group. These results indicate that the depressed group had overall less processing of the words since they did not recall as many items as the non depressed group. Since the groups differed in regard to critical items recalled it was of interest to examine how the groups responded to the accurate items as well. The question raised here is to examine whether the depressed group also recalled fewer items overall then the non depressed group.

The results from Experiment 2 show that the depressed group did in fact recall fewer items than the non-depressed group. Of even more interest is that the difference was not as large as expected which shows that the depressed groups memory is intact when compared to the non depressed group. This finding suggests that the depressed group is able to recall information that was presented accurately, but are unable to generate implicit responses to items that were not presented.

This implies that the depressed individuals semantic spreading activation ability is 'suppressed' in the sense that as words from the list are presented, the unpresented critical item is not being activated. Whereas in the non depressed group spreading activation occurs which leads to the activation of the critical item and the subsequent recollection of this item during the free recall part of the experiment.

Another analysis examined how the groups differed in recognition memory for the accurate and critical items. The results show that both groups recognized about the same number of accurate items but differed significantly on the critical items. The simple effects analysis for the critical items showed a significant difference between the two groups. This further supports the notion that spreading activation may be lessened in the depressed group. A major difference between recall and recognition is that in recognition memory a cue is presented to the participant. In free recall there are no cues or hints. From this it seems that the depressed participants had some spreading activation occur but not enough to elicit a recognition response to the critical items.

The second area Experiment 2 examined were the reaction times for each group. As expected, the depressed group was significantly slower in responding then the non-depressed group. The results show that across both the critical items and accurate items the depressed group responded almost 200 ms slower than the non depressed group. The depressed group was about 300 ms slower than the non depressed group for the critical items only.

The data show that the non-depressed group responded significantly faster overall. Also, they responded even faster to the critical items than the accurate items. In contrast, the depressed group responded faster to the accurate items then the critical

items. Again, this supports the idea of a 'depressed' semantic spreading activation network since the accurate items were recalled faster. Also, this effect needs to be replicated in the future with clinically depressed individuals to examine if this effect is even more robust.

The results taken together clearly show that the depressed group differed significantly in how they responded across both items recalled and reaction times. This data can be used to further assess physiological differences in cognitive functioning between depressed and non-depressed individuals. Depressed individuals show that their base rate reaction times are much slower than non-depressed which is correlated with neural activity. Previous research on mood and memory has replicated this finding (Hickie, Ward, Scott, Haindi, Walker, Dixon, & Turner, 1999). The contribution of this experiment shows that there are reliable and robust differences in depressed individuals on the formation of false memory for critical items. These results can be used as a catalyst to design further experiments which will focus on other possible variables that may contribute to these group differences.

Limitations

Possible limitations of Experiment 1 and Experiment 2 were the control of the depth of processing among the groups. Although a depth of processing effect was obtained in this study in the future if could be manipulated even more stringently. It is very difficult to measure exactly how much or how little a participant is processing each word. In this experiment depth of processing was manipulated by having the participants either count syllables or imagine the words. It was expected that counting syllables would cause less processing to occur in the low processing groups. This did work to a degree

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but perhaps making the task more difficult would increase the effect. This could have been accomplished by having the interval between each word decreased as well as making the low processing task more difficult. Participants in the low depth of processing group could have been made to count the number of letters of each word and then count the number of syllables also.

Another limitation was the lack of significant results for the frequency variable. Frequency was expected to influence the production of the critical items in some way. It could have been that the critical items frequency ratings were not as accurate as expected. Also, the frequency of the critical item has been shown to not be as important to critical item production from this study. Perhaps the word frequency does play a small role in production of the critical items but it is subsumed by the large effects of concreteness and depth of processing.

A limitation in Experiment 2 is due to the sample size. Since each participant was self selected on the basis of their BDI score complete control and randomization was not possible. With small samples the power of the analysis is affected and the overall variability is diminished to some extent. This is a problem in all experiments that study special populations. It is very difficult to obtain these participants and have enough for a complex design.

Future Research

This study provides the following ideas for future research. First, to use a different type of task for the low depth of processing condition to determine what effect that may have. A second research idea is to assess aging differences in the DRM paradigm. Previous research has been conducted using the DRM and Alzheimer's patients

but the concreteness and depth of processing variables were not examined. Significant differences may occur within the aging population on concreteness effects as well depth of processing. This or future studies could address whether older individuals were affected more by the depth of processing manipulation then the younger group. Also, the extent to which spreading activation occurs in the elderly could be examined via the DRM paradigm. Since overall reaction times slow down during aging. Part of the study that examines reaction times could hold age as a blocking variable or covariate in the design to assess any differences in reaction time on depth of processing or concreteness.

Next, an experiment similar to Experiment 2 to could be performed. This would include generating lists that have positive, negative and neutral types of critical items. By manipulating the affective component of the critical items one can then examine whether this would cause the depressed subjects to actually generate more critical items that were negative then the control group. In this study it was found that depressed subjects did not recall or recognize as many critical items as the control group. According to mood congruence theorists, if depressed participants are presented with negative and positive items they will tend to recall more of the negative items since those items match their mood.

It would be interesting to see whether depressed individuals would also falsely recall more negative types of critical items than positive ones. If this occurs then it indicates that spreading activation does occur in depressed individuals, but is more specific to the types of stimuli that can illicit the production of the critical items. Further, one can also examine reaction times based on their behavioral data to see if depressed individuals also respond faster to the negative items than the positive ones.

A similar study in regard to mood and the DRM would be to replicate this study using the concreteness and depth of processing factors. One would have to collect a sample of depressed and non depressed and randomly assign these subjects to each condition. Another level of the group condition could be adding clinically depressed group. The reason for this additional group would be that the clinically depressed may have a more pronounced biological difference in overall brain functioning then the moderately depressed subjects that were obtained in this study. One could then compare how these three groups varied on production of critical items as well as on reaction times. IF the clinically depressed groups responded similarly to the moderately depressed groups then efficacy for using the BDI as a measure of depression for group assignment within the DRM would be supported.

A final future experimental design would be to collect a large sample of participants (N = 750) using the same experimental procedure except taking out the frequency variable since that was found to not be significant. Then perform a structural equation model to assess how the factors of reaction time, number of critical items, accurate items and perhaps BDI score are related and develop a model of these inter relationships.

Conclusions

The results of Experiment 1 supported the hypothesis that concreteness and depth of processing would influence the production of the critical items. However, frequency was not a significant factor in the production of critical items or in the reaction time measures. The design of this experiment helped to provide answers to how factors such as concreteness and depth of processing influence the production of critical items in the

Deese-Roediger-McDermott paradigm. Further, the results of this study present reaction times that can be used to assess how these variables affect production of critical items.

Further, the use of the DRM lists for examining depth of processing and concreteness proved to be an satisfactory way to examine the production of critical items. Using five lists for each group proved to be an adequate number to generate significant differences among the groups. Previous studies have used upwards of twenty lists for each participant. This could be viewed as an unrealistic task since the sheer number of list learning may induce fatigue of the participant. With this smaller number of lists once can be assured that the participant will not get overly tired or bored.

The results of experiment 2 provide information on how depressed and non depressed individuals respond to the DRM. There is a dearth of research in this realm and the results from this study can lead future research into the effect of mood on false memory production.

Another area of interest in regard to the depressed data is the influence of affective critical items. In this study most of the critical items had a neutral or positive affective tone to them. If negative critical item lists were created, one would expect the depressed group to have significantly more recalled and recognized than the non depressed group. Further, the reaction times to this items should be significantly different between the groups as well.

Overall, the results obtained from Experiment 1 and 2 are of great heuristic value. They have generated more questions than answers and the design of this experiment can lead to future experiments on mood and memory.

CHAPTER VII

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APPENDIX A

Word Lists

Low Frequency/ Low Concrete

SLOW	FOOT	ANGER	ROUGH	SWIFT
FAST	SHOE	MAD	SMOOTH	FAST
LETHARGIC	HAND	FEAR	BUMPY	SLOW
STOP	TOE	HATE	ROAD	RIVER
LISTLESS	KICK	RAGE	TOUGH	JONATHON
SNAIL	SANDAL	TEMPER	SANDPAPER	CURRENT
CAUTIOUS	SOCCER	FURY	JAGGED	RAPID
DELAY	YARD	IRE	READY	STREAM
TRAFFIC	WALK	WRATH	COARSE	WATER
TURTLE	ANKLE	HAPPY	UNEVEN	QUICK
HESISTANT	ARM	FIGHT	RIDERS	GULLIVER
SPEED	BOOT	HATRED	RUGGED	RUN
QUICK	INCH	MEAN	SAND	SURE
SLUGGISH	SOCK	CALM	BOARDS	DEER
WAIT	KNEE	EMOTION	GROUND	CAR
MOLASSES	MOUTH	ENRAGE	GRAVEL	AUTHOR

Low Frequency/ High Concrete

LION	SPIDER	TRASH	BREAD	CHAIR
TIGER	WEB	GARBAGE	BUTTER	TABLE
CIRCUS	INSECT	WASTE	FOOD	SIT
JUNGLE	BUG	CAN	EAT	LEGS
TAMER	FRIGHT	REFUSE	SANDWICH	SEAT
DEN	FLY	SEWAGE	RYE	COUCH
CUB	ARACHNID	BAG	JAM	DESK
AFRICA	CRAWL	JUNK	MILK	RECLINER
MANE	TARANTULA	RUBBISH	FLOUR	SOFA
CAGE	POSION	SWEEP	JELLY	WOOD
FELINE	BITE	SCRAPS	DOUGH	CUSHION
ROAR	CREEPY	PILE	CRUST	SWIVEL
FIERCE	ANIMAL	DUMP	SLICE	STOOL
PAWS	UGLY	LANDFILL	WINE	SITTING
HUNT	FEELERS	DEBRIS	LOAF	ROCKING
PRIDE	SMALL	LITTER	TOAST	BENCH

High Frequency/ Low Concrete

JUSTICE	HIGH	BLACK	COLD	WISH
PEACE	LOW	WHITE	HOT	WANT
LAW	CLOUDS	DARK	SNOW	DREAM
COURTS	UP	CAT	WARM	DESIRE
JUDGE	TALL	CHARRED	WINTER	HOPE
RIGHT	TOWER	NIGHT	ICE	WELL
LIBERTY	JUMP	FUNERAL	WET	THINK
GOVERNMENT	ABOVE	COLOR	FRIGID	STAR
JURY	BUILDING	GRIEF	CHILLY	BONE
TRUTH	NOON	BLUE	HEAT	RING
BLIND	CLIFF	DEATH	WEATHER	WASH
FAIR	SKY	INK	FREEZE	THOUGHT
SUPREME	OVER	BOTTOM	AIR	GET
CRIME	AIRPLANE	COAL	SHIVER	TRUE
DEPARTMENT	DIVE	BROWN	ARCTIC	FOR
TRIAL	ELEVATE	GRAY	FROST	MONEY

High Frequency/ High Concrete

CAR	CITY	GIRL	RIVER	WINDOW
TRUCK	TOWN	BOY	WATER	DOOR
BUS	CROWDED	DOLLS	STREAM	GLASS
TRAIN	STATE	FEMALE	LAKE	PANE
AUTOMOBILE	CAPITAL	YOUNG	MISSISSIPPI	SHADE
VEHICLE	STREETS	DRESS	BOAT	LEDGE
DRIVE	SUBWAY	PRETTY	TIDE	SILL
JEEP	COUNTRY	HAIR	SWIM	HOUSE
FORD	NEW YORK	NEICE	FLOW	OPEN
RACE	VILLAGE	DANCE	RUN	CURTAIN
KEYS	METROPOLIS	BEAUTIFUL	BARGE	FRAME
GARAGE	BIG	CUTE	CREEK	VIEW
HIGHWAY	CHICAGO	DATE	BROOK	BREEZE
SEDAN	SUBURB	AUNT	FISH	SASH
VAN	COUNTRY	DAUGHTER	BRIDGE	SCREEN
TAXI	URBAN	SISTER	WINDING	SHUTTER

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APPENDIX B

Reaction time Data for each Group

Dissertation Data: Group 1

```
subject = 001g1
                              CORRECT TRIALS
 Words on List
785     22
 Unrelated Words
798     30
Critical Items
********************************************************************
                              INCORRECT TRIALS
 Words on List
862     5
 Unrelated Words
586     1
 Critical Items
615     4

subject = 002g1
                              CORRECT TRIALS
 Words on List
718     23
 Unrelated Words
812     27
Critical Items
994     2
********************************************************************
                              INCORRECT TRIALS
 Words on List
823     7
 Unrelated Words
838     3
Critical Items
771     3
subject = 003g1
                              CORRECT TRIALS
 Words on List
866     28
 Unrelated Words
834     27
Critical Items
********************************************************************
                              INCORRECT TRIALS
 Words on List
788     2
 Unrelated Words
1223    3
Critical Items
758     4

subject = 004g1
                              CORRECT TRIALS
 Words on List
874     27
 Unrelated Words
866     30
Critical Items
********************************************************************
                              INCORRECT TRIALS
 Words on List
1136    2
 Unrelated Words
570     1
 Critical Items
576     5
```

93

```
subject = 005g1
                          CORRECT TRIALS
 Words on List
832      23
 Unrelated Words
816      25
Critical Items
************************************************************
                         INCORRECT TRIALS
 Words on List
883       7
 Unrelated Words
870       4
Critical Items
891       5


subject = 006g1
                          CORRECT TRIALS
 Words on List
706      26
 Unrelated Words
724      26
Critical Items
************************************************************
                         INCORRECT TRIALS
 Words on List
901       4
 Unrelated Words
733       4
Critical Items
578       4


subject = 007g1
                          CORRECT TRIALS
 Words on List
687      27
 Unrelated Words
782      30
Critical Items
899       1
************************************************************
                         INCORRECT TRIALS
 Words on List
836       3
 Unrelated Words
Critical Items
670       4


subject = 008g1
                          CORRECT TRIALS
 Words on List
659      20
 Unrelated Words
695      27
Critical Items
767       3
************************************************************
                         INCORRECT TRIALS
 Words on List
873      10
 Unrelated Words
597       3
Critical Items
785       2
```

```
subject = 009g1
                              CORRECT TRIALS
 Words on List
914     24
 Unrelated Words
1028    28
Critical Items
****************************************************************
                              INCORRECT TRIALS
 Words on List
1113    5
 Unrelated Words
855     2
Critical Items
840     5


subject = 010g1
                              CORRECT TRIALS
 Words on List
815     26
 Unrelated Words
935     25
Critical Items
****************************************************************
                              INCORRECT TRIALS
 Words on List
1162    4
 Unrelated Words
985     4
Critical Items
787     4


subject = 011g1
                              CORRECT TRIALS
 Words on List
743     22
 Unrelated Words
738     23
Critical Items
243     2
****************************************************************
                              INCORRECT TRIALS
 Words on List
801     7
 Unrelated Words
579     7
Critical Items
791     3


subject = 012g1
                              CORRECT TRIALS
 Words on List
822     20
 Unrelated Words
691     29
Critical Items
1184    1
****************************************************************
                              INCORRECT TRIALS
 Words on List
713     10
 Unrelated Words
855     1
Critical Items
699     4
```

95

```
subject = 013g1
                              CORRECT TRIALS
 Words on List
941     22
 Unrelated Words
961     24
Critical Items
855     1
***************************************************************
                              INCORRECT TRIALS
 Words on List
1152    8
 Unrelated Words
1025    6
Critical Items
895     4


subject = 014g1
                              CORRECT TRIALS
 Words on List
779     25
 Unrelated Words
845     29
Critical Items
945     1
***************************************************************
                              INCORRECT TRIALS
 Words on List
986     5
 Unrelated Words
620     1
 Critical Items
708     4


subject = 015g1
                              CORRECT TRIALS
 Words on List
889     18
 Unrelated Words
989     28
Critical Items
807     1
***************************************************************
                              INCORRECT TRIALS
 Words on List
1011    12
 Unrelated Words
804     1
Critical Items
800     4


subject = 016g1
                              CORRECT TRIALS
 Words on List
723     20
 Unrelated Words
717     23
Critical Items
754     1
***************************************************************
                              INCORRECT TRIALS
 Words on List
960     10
 Unrelated Words
910     7
Critical Items
628     4
```

```
subject = 017g1
                          CORRECT TRIALS
 Words on List
1461    21
 Unrelated Words
1433    29
 Critical Items
 ***************************************************************
                          INCORRECT TRIALS
 Words on List
1627    7
 Unrelated Words
1771    1
 Critical Items
1462    5


subject = 018g1
                          CORRECT TRIALS
 Words on List
803     25
 Unrelated Words
782     29
 Critical Items
 ***************************************************************
                          INCORRECT TRIALS
 Words on List
913     5
 Unrelated Words
788     1
 Critical Items
687     4


subject = 019g1
                          CORRECT TRIALS
 Words on List
861     25
 Unrelated Words
870     26
 Critical Items
 ***************************************************************
                          INCORRECT TRIALS
 Words on List
1109    5
 Unrelated Words
791     3
Critical Items
926     5


subject = 020g1
                          CORRECT TRIALS
 Words on List
950     22
 Unrelated Words
936     29
 Critical Items
 ***************************************************************
                          INCORRECT TRIALS
 Words on List
986     8
 Unrelated Words
737     1
Critical Items
912     5
```

```
subject = 021g1
                         CORRECT TRIALS
 Words on List
980     19
 Unrelated Words
823     29
*****************************************************************
                         INCORRECT TRIALS
 Words on List
981     10
 Unrelated Words
838     1
 Critical Items
977     5


subject = 022g1
                         CORRECT TRIALS
 Words on List
769     23
 Unrelated Words
827     27
Critical Items
1129    2
*****************************************************************
                         INCORRECT TRIALS
 Words on List
1023    6
 Unrelated Words
936     3
Critical Items
625     3


subject = 023g1
                         CORRECT TRIALS
 Words on List
972     22
 Unrelated Words
986     29
Critical Items
*****************************************************************
                         INCORRECT TRIALS
 Words on List
1303    8
 Unrelated Words
1352    1
Critical Items
870     5


subject = 024g1
                         CORRECT TRIALS
 Words on List
1078    26
 Unrelated Words
1366    23
Critical Items
*****************************************************************
                         INCORRECT TRIALS
 Words on List
1201    1
 Unrelated Words
1208    3
Critical Items
953     5


subject = 025g1
                         CORRECT TRIALS
 Words on List
911     23
 Unrelated Words
1175    25
Critical Items
```

```
*****************************************************************
                        INCORRECT TRIALS
 Words on List
1597    3
 Unrelated Words
1251    2
Critical Items
1157    4


subject = 026g1
                        CORRECT TRIALS
 Words on List
907     17
 Unrelated Words
1055    24
Critical Items
1083    1
*****************************************************************
                        INCORRECT TRIALS
 Words on List
1005    12
 Unrelated Words
1231    4
Critical Items
765     3


subject = 027g1
                        CORRECT TRIALS
 Words on List
680     22
 Unrelated Words
663     26
Critical Items
519     1
*****************************************************************
                        INCORRECT TRIALS
 Words on List
761     5
 Unrelated Words
720     3
Critical Items
624     4


subject = 028g1
                        CORRECT TRIALS
 Words on List
915     21
 Unrelated Words
878     29
Critical Items
*****************************************************************
                        INCORRECT TRIALS
 Words on List
1209    8
 Unrelated Words
788     1
 Critical Items
882     4




subject = 029g1
                        CORRECT TRIALS
 Words on List
672     25
 Unrelated Words
902     10
Critical Items
899     1
*****************************************************************
```

99

```
 Words on List
762     4
 Unrelated Words
720     18
Critical Items
974     4
```

subject = 030g1

CORRECT TRIALS
```
 Words on List
884     30
 Unrelated Words
1039    18
Critical Items
```
```
****************************************************************
```
INCORRECT TRIALS
```
 Words on List
 Unrelated Words
1030    11
Critical Items
750     4
```

subject = 031g1

CORRECT TRIALS
```
 Words on List
945     27
 Unrelated Words
1010    27
Critical Items
1259    1
```
```
****************************************************************
```
INCORRECT TRIALS
```
 Words on List
871     3
 Unrelated Words
1353    3
Critical Items
766     4
```

subject = 032g1

CORRECT TRIALS
```
 Words on List
998     28
 Unrelated Words
1156    27
Critical Items
1089    1
```
```
****************************************************************
```
INCORRECT TRIALS
```
 Words on List
1251    2
 Unrelated Words
1452    1
Critical Items
979     4
```

```
subject = 033g2
                              CORRECT TRIALS
 Words on List
889     25
 Unrelated Words
1093    25
Critical Items
*****************************************************************
                              INCORRECT TRIALS
 Words on List
1143    4
 Unrelated Words
956     5
Critical Items
783     4


subject = 034g2
                              CORRECT TRIALS
 Words on List
997     21
 Unrelated Words
1134    29
Critical Items
1102    1
*****************************************************************
                              INCORRECT TRIALS
 Words on List
1425    7
 Unrelated Words
1939    1
 Critical Items
732     3


subject = 035g2
                              CORRECT TRIALS
 Words on List
1012    21
 Unrelated Words
1111    26
Critical Items
987     1
*****************************************************************
                              INCORRECT TRIALS
 Words on List
1272    7
 Unrelated Words
1393    2
Critical Items
758     4


subject = 036g2
                              CORRECT TRIALS
 Words on List
853     25
 Unrelated Words
943     30
 Critical Items
*****************************************************************
                              INCORRECT TRIALS
 Words on List
1134    5
 Unrelated Words
Critical Items
766     4
```

```
subject = 065g2
                            CORRECT TRIALS
 Words on List
909     30
 Unrelated Words
1017    26
Critical Items
1570    1
*****************************************************************
                            INCORRECT TRIALS
 Words on List
 Unrelated Words
1079    3
 Critical Items
1203    4


subject = 066g3
                            CORRECT TRIALS
 Words on List
618     23
 Unrelated Words
788     21
Critical Items
*****************************************************************
                            INCORRECT TRIALS
 Words on List
1021    7
 Unrelated Words
820     9
Critical Items
755     5


subject = 067g2
                            CORRECT TRIALS
 Words on List
789     13
 Unrelated Words
735     29
Critical Items
1167    1
*****************************************************************
                            INCORRECT TRIALS
 Words on List
872     17
 Unrelated Words
603     1
 Critical Items
733     4


subject = 068g2
                            CORRECT TRIALS
 Words on List
780     21
 Unrelated Words
933     29
Critical Items
*****************************************************************
                            INCORRECT TRIALS
 Words on List
948     8
 Unrelated Words
712     1
 Critical Items
817     5
```

```
subject = 069g2
                          CORRECT TRIALS

 Words on List
744      25
 Unrelated Words
844      28
Critical Items
****************************************************************
                          INCORRECT TRIALS

 Words on List
928      5
 Unrelated Words
804      1
Critical Items
647      5


 subject = 070g2
                          CORRECT TRIALS

 Words on List
781      24
 Unrelated Words
775      29
Critical Items
****************************************************************
                          INCORRECT TRIALS

 Words on List
845      6
 Unrelated Words
670      1
Critical Items
695      4


subject = 071g2
                          CORRECT TRIALS

 Words on List
833      24
 Unrelated Words
1080     25
Critical Items
721      1
****************************************************************
                          INCORRECT TRIALS

 Words on List
1115     5
 Unrelated Words
976      5
Critical Items
804      3


subject = 072g2
                          CORRECT TRIALS

 Words on List
883      24
 Unrelated Words
874      29
Critical Items
939      1
****************************************************************
                          INCORRECT TRIALS

 Words on List
814      6
 Unrelated Words
910      1
 Critical Items
708      4
```

```
subject = 073g2
                              CORRECT TRIALS
 Words on List
861      29
 Unrelated Words
933      24
Critical Items
*****************************************************************
                            INCORRECT TRIALS
 Words on List
1050     1
 Unrelated Words
1087     2
Critical Items
1197     5


subject = 074g2
                              CORRECT TRIALS
 Words on List
826      19
 Unrelated Words
793      29
Critical Items
*****************************************************************
                            INCORRECT TRIALS
 Words on List
939      11
 Unrelated Words
670      1
Critical Items
703      4


subject = 075g2
                              CORRECT TRIALS
 Words on List
980      23
 Unrelated Words
1060     29
Critical Items
*****************************************************************
                             INCORRECT TRIALS
 Words on List
1267     7
 Unrelated Words
519      1
 Critical Items
 1013    5


subject = 076g2
                              CORRECT TRIALS
 Words on List
1037     25
 Unrelated Words
1028     23
Critical Items
728      1
*****************************************************************
                            INCORRECT TRIALS
 Words on List
1168     4
 Unrelated Words
1609     4
Critical Items
813      4


subject = 077g2
                              CORRECT TRIALS
 Words on List
956      21
 Unrelated Words
775      29
```

```
*******************************************************************
                            INCORRECT TRIALS
 Words on List
991      9
 Unrelated Words
Critical Items
952      5


subject = 078g2
                            CORRECT TRIALS
 Words on List
819      27
 Unrelated Words
782      28
Critical Items
939      1
*******************************************************************
                            INCORRECT TRIALS
 Words on List
1143     3
 Unrelated Words
670      1
Critical Items
699      4


subject = 099g2
                            CORRECT TRIALS
 Words on List
867      22
 Unrelated Words
786      26
Critical Items
*******************************************************************
                            INCORRECT TRIALS
 Words on List
859      8
 Unrelated Words
819      3
Critical Items
788      5


subject = 115g2
                            CORRECT TRIALS
 Words on List
1028     24
 Unrelated Words
957      28
Critical Items
*******************************************************************
                            INCORRECT TRIALS
 Words on List
1306     5
 Unrelated Words
1167     1
Critical Items
989      5
```

```
subject = 116g2
                          CORRECT TRIALS
 Words on List
881     27
 Unrelated Words
789     29
Critical Items
952     2
******************************************************************
                          INCORRECT TRIALS
 Words on List
819     3
 Unrelated Words
628     1
 Critical Items
753     3


subject = 117g2
                          CORRECT TRIALS
 Words on List
1263    25
 Unrelated Words
1334    29
Critical Items
1352    1
******************************************************************
                          INCORRECT TRIALS
 Words on List
1295    3
 Unrelated Words
1251    1
 Critical Items
1461    4


subject = 118g2
                          CORRECT TRIALS
 Words on List
941     27
 Unrelated Words
843     28
Critical Items
******************************************************************
                          INCORRECT TRIALS
 Words on List
1219   · 3
 Unrelated Words
1637    1
Critical Items
882     5


subject = 119g2
                          CORRECT TRIALS
 Words on List
912     26
 Unrelated Words
1045    29
Critical Items
******************************************************************
                          INCORRECT TRIALS
 Words on List
1244    4
 Unrelated Words
888     1
 Critical Items
883     5
```

```
subject = 120g2
                          CORRECT TRIALS
 Words on List
787      22
 Unrelated Words
827      29
Critical Items
687      1
***************************************************************
                          INCORRECT TRIALS
 Words on List
890      8
 Unrelated Words
771      1
 Critical Items
691      4


subject = 121g2
                          CORRECT TRIALS
 Words on List
1090     15
 Unrelated Words
904      28
Critical Items
687      1
***************************************************************
                          INCORRECT TRIALS
 Words on List
1131     14
 Unrelated Words
821      1
Critical Items
1156     4


subject = 122g2
                          CORRECT TRIALS
 Words on List
819      24
 Unrelated Words
810      25
Critical Items
***************************************************************
                          INCORRECT TRIALS
 Words on List
825      6
 Unrelated Words
831      4
Critical Items
757      5


subject = 189g3
                          CORRECT TRIALS
 Words on List
828      26
 Unrelated Words
791      29
Critical Items
692      3
***************************************************************
                          INCORRECT TRIALS
 Words on List
908      3
 Unrelated Words
855      1
Critical Items
771      2
```

```
subject = 197g2
                            CORRECT TRIALS
 Words on List
875     28
 Unrelated Words
797     29
Critical Items
1360    2
**********************************************************************
                            INCORRECT TRIALS
 Words on List
843     2
 Unrelated Words
1131    1
 Critical Items
1083    2


subject = 198g2
                            CORRECT TRIALS
 Words on List
813     24
 Unrelated Words
779     27
Critical Items
**********************************************************************
                            INCORRECT TRIALS
 Words on List
963     6
 Unrelated Words
704     2
Critical Items
757     5
```

Dissertation Data: Group 3

```
subject = 037g3
                            CORRECT TRIALS
 Words on List
1064    26
 Unrelated Words
986     28
Critical Items
1430    3
**********************************************************************
                            INCORRECT TRIALS
 Words on List
1200    2
 Unrelated Words
838     1
Critical Items
880     2


subject = 038g3
                            CORRECT TRIALS
 Words on List
941     27
 Unrelated Words
1151    30
Critical Items
1821    1
**********************************************************************
                            INCORRECT TRIALS
 Words on List
1155    3
 Unrelated Words
Critical Items
720     4
```

```
subject = 039g3
                         CORRECT TRIALS
 Words on List
891     26
 Unrelated Words
933     29
Critical Items
570     1
*****************************************************************
                         INCORRECT TRIALS
 Words on List
970     3
 Unrelated Words
939     1
Critical Items
729     4


subject = 040g3
                         CORRECT TRIALS
 Words on List
1121    24
 Unrelated Words
1141    27
Critical Items
*****************************************************************
                         INCORRECT TRIALS
 Words on List
1210    4
 Unrelated Words
1134    1
Critical Items
1009    5


subject = 041g3
                         CORRECT TRIALS
 Words on List
806     21
 Unrelated Words
873     28
Critical Items
945     1
*****************************************************************
                         INCORRECT TRIALS
 Words on List
1030    8
 Unrelated Words
779     2
Critical Items
749     4


subject = 042g3
                         CORRECT TRIALS
 Words on List
1283    23
 Unrelated Words
1336    25
Critical Items
1922    1
*****************************************************************
                         INCORRECT TRIALS
 Words on List
1238    2
 Unrelated Words
981     2
Critical Items
1007    4
```

```
subject = 043g3
                              CORRECT TRIALS
 Words on List
889      27
 Unrelated Words
1026     29
Critical Items
809       1
*******************************************************************
                              INCORRECT TRIALS
 Words on List
955       1
 Unrelated Words
Critical Items
625       3


subject = 044g3
                              CORRECT TRIALS
 Words on List
1201     25
 Unrelated Words
1117     28
Critical Items
1259      2
*******************************************************************
                              INCORRECT TRIALS
 Words on List
1788      3
 Unrelated Words
1251      1
Critical Items
991       3


subject = 045g3
                              CORRECT TRIALS
 Words on List
1076     17
 Unrelated Words
958      28
Critical Items
1352      1
*******************************************************************
                              INCORRECT TRIALS
 Words on List
1327      5
 Unrelated Words
1067      1
Critical Items
1077      4


 subject = 046g3
                              CORRECT TRIALS
 Words on List
805      20
 Unrelated Words
781      28
Critical Items
788       1
*******************************************************************
                              INCORRECT TRIALS
 Words on List
817       8
 Unrelated Words
1033      1
Critical Items
665       4
```

110

```
subject = 047g3
                              CORRECT TRIALS
 Words on List
795     25
 Unrelated Words
802     28
Critical Items
*****************************************************************
                              INCORRECT TRIALS
 Words on List
952     4
 Unrelated Words
843     2
Critical Items
676     5


subject = 048g3
                              CORRECT TRIALS
 Words on List
1140    24
 Unrelated Words
878     29
Critical Items
*****************************************************************
                              INCORRECT TRIALS
 Words on List
1316    5
 Unrelated Words
1251    1
Critical Items
1100    5


subject = 049g3
                              CORRECT TRIALS
 Words on List
983     21
 Unrelated Words
1257    26
Critical Items
*****************************************************************
                              INCORRECT TRIALS
 Words on List
1502    3
 Unrelated Words
1511    2
Critical Items
1010    5


subject = 050g3
                              CORRECT TRIALS
 Words on List
941     10
 Unrelated Words
932     27
Critical Items
1139    4
*****************************************************************
                              INCORRECT TRIALS
 Words on List
919     20
 Unrelated Words
1137    2
Critical Items
1687    1
```

```
subject = 051g3
                        CORRECT TRIALS
 Words on List
976     25
 Unrelated Words
932     28
Critical Items
1269    2
*****************************************************************
                        INCORRECT TRIALS
 Words on List
1142    4
 Unrelated Words
972     1
Critical Items
897     3


subject = 052g3
                        CORRECT TRIALS
 Words on List
790     22
 Unrelated Words
992     26
Critical Items
*****************************************************************
                        INCORRECT TRIALS
 Words on List
1090    7
 Unrelated Words
888     2
Critical Items
693     5


subject = 053g3
                        CORRECT TRIALS
 Words on List
1042    28
 Unrelated Words
1343    15
Critical Items
*****************************************************************
                        INCORRECT TRIALS
 Words on List
1201    1
 Unrelated Words
1185    8
Critical Items
 863    5


subject = 054g3
                        CORRECT TRIALS
 Words on List
848     15
 Unrelated Words
886     29
Critical Items
804     1
*****************************************************************
                        INCORRECT TRIALS
 Words on List
1076    10
 Unrelated Words
620     1
Critical Items
813     4
```

```
subject = 055g3
                            CORRECT TRIALS
 Words on List
827     25
 Unrelated Words
1025    26
Critical Items
*****************************************************************
                            INCORRECT TRIALS
 Words on List
1119    3
 Unrelated Words
785     3
Critical Items
660     5


subject = 056g3
                            CORRECT TRIALS
 Words on List
1240    19
 Unrelated Words
1352    26
Critical Items
*****************************************************************
                            INCORRECT TRIALS
 Words on List
1477    6
 Unrelated Words
1219    2
Critical Items
1166    5


subject = 057g3
                            CORRECT TRIALS
 Words on List
749     26
 Unrelated Words
853     27
Critical Items
*****************************************************************
                            INCORRECT TRIALS
 Words on List
1068    3
 Unrelated Words
720     2
Critical Items
670     5


subject = 058g3
                            CORRECT TRIALS
 Words on List
949     21
 Unrelated Words
1002    29
Critical Items
*****************************************************************
                            INCORRECT TRIALS
 Words on List
1253    7
 Unrelated Words
721     1
Critical Items
873     5
```

113

```
Subject = 059g3
                            CORRECT TRIALS
 Words on List
970      17
 Unrelated Words
918      28
Critical Items
1804     2
*****************************************************************
                            INCORRECT TRIALS
 Words on List
1082     7
 Unrelated Words
737      1
Critical Items
816      3


subject = 060g3
                            CORRECT TRIALS
 Words on List
1154     25
 Unrelated Words
1372     29
Critical Items
1972     1
*****************************************************************
                            INCORRECT TRIALS
 Words on List
1821     1
 Unrelated Words
1318     1
Critical Items
1114     4


subject = 061g3
                            CORRECT TRIALS
 Words on List
1009     19
 Unrelated Words
1046     27
Critical Items
986      1
*****************************************************************
                            INCORRECT TRIALS
 Words on List
1171     8
 Unrelated Words
1167     1
Critical Items
850      4


subject = 062g3
                            CORRECT TRIALS
 Words on List
982      21
 Unrelated Words
985      25
Critical Items
704      1
*****************************************************************
                            INCORRECT TRIALS
 Words on List
1089     8
 Unrelated Words
1031     3
Critical Items
919      4
```

114

```
subject = 064g3
                          CORRECT TRIALS
 Words on List
715      26
 Unrelated Words
847      20
Critical Items
****************************************************************
                          INCORRECT TRIALS
 Words on List
1087     3
 Unrelated Words
740      9
Critical Items
754      5


subject = 066g3
                          CORRECT TRIALS
 Words on List
768      22
 Unrelated Words
804      21
Critical Items
****************************************************************
                          INCORRECT TRIALS
 Words on List
1001     7
 Unrelated Words
880       9
Critical Items
1020     5


subject = 123g3
                          CORRECT TRIALS
 Words on List
800      25
 Unrelated Words
763      27
Critical Items
703      2
****************************************************************
                          INCORRECT TRIALS
 Words on List
1206     4
 Unrelated Words
969      2
Critical Items
714      3


subject = 188g3
                          CORRECT TRIALS
 Words on List
897      19
 Unrelated Words
928      20
Critical Items
****************************************************************
                          INCORRECT TRIALS
 Words on List
903      10
 Unrelated Words
976      9
Critical Items
884      5
```

```
subject = 262g3
                              CORRECT TRIALS
 Words on List
811      24
 Unrelated Words
925      28
Critical Items
********************************************************************
                              INCORRECT TRIALS
 Words on List
1154     4
 Unrelated Words
670      1
Critical Items
720      5


subject = 263g3
                              CORRECT TRIALS
 Words on List
913      22
 Unrelated Words
963      25
Critical Items
********************************************************************
                              INCORRECT TRIALS
 Words on List
1045     6
 Unrelated Words
945      4
Critical Items
969      5
```

Dissertation Data: Group 4

```
subject = 080g4
                              CORRECT TRIALS
 Words on List
827      25
 Unrelated Words
957      26
Critical Items
********************************************************************
                              INCORRECT TRIALS
 Words on List
920      4
 Unrelated Words
863      3
Critical Items
677      5


subject = 082g4
                              CORRECT TRIALS
 Words on List
793      25
 Unrelated Words
964      26
Critical Items
789      1
********************************************************************
                              INCORRECT TRIALS
 Words on List
999      4
 Unrelated Words
1001     3
Critical Items
703      4
```

```
subject = 083g4
                              CORRECT TRIALS
 Words on List
1103    17
 Unrelated Words
1371    22
Critical Items
1433    2
******************************************************************
                              INCORRECT TRIALS
 Words on List
1354    10
 Unrelated Words
1375    3
Critical Items
1106    4


subject = 084g4
                              CORRECT TRIALS
 Words on List
856     22
 Unrelated Words
941     24
Critical Items
781     1
******************************************************************
                              INCORRECT TRIALS
 Words on List
1024    7
 Unrelated Words
1163    5
Critical Items
914     4


 subject = 085g4
                              CORRECT TRIALS
 Words on List
916     24
 Unrelated Words
1032    29
Critical Items
******************************************************************
                              INCORRECT TRIALS
 Words on List
1126    5
 Unrelated Words
939     1
Critical Items
844     5


 subject = 086g4
                              CORRECT TRIALS
 Words on List
832     26
 Unrelated Words
842     30
Critical Items
******************************************************************
                              INCORRECT TRIALS
 Words on List
1232    5
 Unrelated Words
893     2
Critical Items
813     5
```

```
subject = 087g4
                              CORRECT TRIALS
 Words on List
708      22
 Unrelated Words
774      29
Critical Items
969      2
*****************************************************************
                              INCORRECT TRIALS
 Words on List
988      7
 Unrelated Words
Critical Items
659      3


subject = 088g4
                              CORRECT TRIALS
 Words on List
836      24
 Unrelated Words
874      28
Critical Items
905      2
*****************************************************************
                              INCORRECT TRIALS
 Words on List
956      5
 Unrelated Words
754      1
Critical Items
703      3


subject = 089g4
                              CORRECT TRIALS
 Words on List
810      26
 Unrelated Words
661      28
Critical Items
994      2
*****************************************************************
                              INCORRECT TRIALS
 Words on List
1046     3
 Unrelated Words
335      1
Critical Items
974      3


subject = 090g4
                              CORRECT TRIALS
 Words on List
748      21
 Unrelated Words
802      28
Critical Items
*****************************************************************
                              INCORRECT TRIALS
 Words on List
1081     8
 Unrelated Words
654      1
Critical Items
700      5
```

```
subject = 091g4
                              CORRECT TRIALS

 Words on List
744      25
 Unrelated Words
958      23
Critical Items
************************************************************
                              INCORRECT TRIALS

 Words on List
1058     4
 Unrelated Words
762      6
Critical Items
680      5


subject = 092g4
                              CORRECT TRIALS

 Words on List
853      27
 Unrelated Words
797      27
 Critical Items
1134     1
************************************************************
                              INCORRECT TRIALS

 Words on List
1083     2
 Unrelated Words
1288     2
Critical Items
931      4


subject = 093g4
                              CORRECT TRIALS

 Words on List
741      28
 Unrelated Words
851      23
Critical Items
************************************************************
                              INCORRECT TRIALS

 Words on List
 Unrelated Words
750      4
Critical Items
593      5


subject = 094g4
                              CORRECT TRIALS

 Words on List
789      24
 Unrelated Words
797      28
Critical Items
************************************************************
                              INCORRECT TRIALS

 Words on List
1022     5
 Unrelated Words
754      1
Critical Items
688      5
```

119

```
subject = 095g4
                            CORRECT TRIALS

 Words on List
954      24
 Unrelated Words
968      28
Critical Items
789       1
****************************************************************
                           INCORRECT TRIALS

 Words on List
1104      5
 Unrelated Words
955       1
Critical Items
691       4


subject = 096g4
                            CORRECT TRIALS

 Words on List
857      23
 Unrelated Words
866      28
Critical Items
****************************************************************
                           INCORRECT TRIALS

 Words on List
967       6
 Unrelated Words
603       1
Critical Items
733       5


subject = 097g4
                            CORRECT TRIALS

 Words on List
820      25
 Unrelated Words
662      28
Critical Items
1002      3
****************************************************************
                           INCORRECT TRIALS

 Words on List
927       4
 Unrelated Words
335       1
Critical Items
852       2


subject = 098g4
                            CORRECT TRIALS

 Words on List
764      25
 Unrelated Words
785      21
Critical Items
****************************************************************
                           INCORRECT TRIALS

 Words on List
890       4
 Unrelated Words
692       8
Critical Items
656       5
```

```
subject = 099g4
                              CORRECT TRIALS

 Words on List
865      25
 Unrelated Words
967      24
Critical Items
688      1
****************************************************************
                             INCORRECT TRIALS

 Words on List
962      4
 Unrelated Words
1000     5
Critical Items
779      4


subject = 100g4
                              CORRECT TRIALS

 Words on List
945      24
 Unrelated Words
921      27
Critical Items
****************************************************************
                             INCORRECT TRIALS

 Words on List
1249     3
 Unrelated Words
821      1
Critical Items
890      5


subject = 101g4
                              CORRECT TRIALS

 Words on List
1003     25
 Unrelated Words
1014     27
Critical Items
1662     2
****************************************************************
                             INCORRECT TRIALS

 Words on List
1357     3
 Unrelated Words
1159     2
Critical Items
1100     3


subject = 102g4
                              CORRECT TRIALS

 Words on List
1028     26
 Unrelated Words
1035     28
Critical Items
****************************************************************
                             INCORRECT TRIALS

 Words on List
1499     3
 Unrelated Words
838      1
Critical Items
783      4
```

```
subject = 103g4
                         CORRECT TRIALS
 Words on List
826     26
 Unrelated Words
954     29
Critical Items
**********************************************************
                         INCORRECT TRIALS
 Words on List
1264    3
 Unrelated Words
Critical Items
646     5


subject = 104g4
                         CORRECT TRIALS
 Words on List
739     23
 Unrelated Words
794     27
Critical Items
**********************************************************
                         INCORRECT TRIALS
 Words on List
929     6
 Unrelated Words
703     2
Critical Items
667     5


subject = 105g4
                         CORRECT TRIALS
 Words on List
822     23
 Unrelated Words
748     28
Critical Items
**********************************************************
                         INCORRECT TRIALS
 Words on List
932     6
 Unrelated Words
771     1
Critical Items
653     5


subject = 106g4
                         CORRECT TRIALS
 Words on List
1127    11
 Unrelated Words
1099    23
Critical Items
770     2
**********************************************************
                         INCORRECT TRIALS
 Words on List
1155    18
 Unrelated Words
789     6
Critical Items
866     3
```

```
subject = 107g4
                         CORRECT TRIALS
 Words on List
978      27
 Unrelated Words
1146     25
Critical Items
*****************************************************************
                         INCORRECT TRIALS
 Words on List
1310     2
 Unrelated Words
1219     3
Critical Items
792      5


subject = 108g4
                         CORRECT TRIALS
 Words on List
797      27
 Unrelated Words
949      28
Critical Items
654      1
*****************************************************************
                         INCORRECT TRIALS
 Words on List
838      2
 Unrelated Words
620      1
Critical Items
1107     4


 subject = 109g4
                         CORRECT TRIALS
 Words on List
1013     4
 Unrelated Words
754      8
Critical Items
673      5
*****************************************************************
                         INCORRECT TRIALS
 Words on List
770      25
 Unrelated Words
880      20
Critical Items


subject = 110g4
                         CORRECT TRIALS
 Words on List
1005     23
 Unrelated Words
1102     27
Critical Items
*****************************************************************
                         INCORRECT TRIALS
 Words on List
1202     6
 Unrelated Words
1385     1
Critical Items
988      5
```

```
subject = 111g4
                          CORRECT TRIALS
 Words on List
866     23
 Unrelated Words
786     28
Critical Items
******************************************************************
                          INCORRECT TRIALS
 Words on List
950     5
 Unrelated Words
788     1
Critical Items
663     5


subject = 112g4
                          CORRECT TRIALS
 Words on List
1014    25
 Unrelated Words
1194    24
Critical Items
******************************************************************
                          INCORRECT TRIALS
 Words on List
1074    4
 Unrelated Words
1199    4
Critical Items
821     5


subject = 114g4
                          CORRECT TRIALS
 Words on List
1329    21
 Unrelated Words
1369    28
Critical Items
******************************************************************
                          INCORRECT TRIALS
 Words on List
1336    3
 Unrelated Words
1191    2
Critical Items
929     5
```

Dissertation Data: Group 5

```
subject = 190g5
                          CORRECT TRIALS
 Words on List
1077    21
 Unrelated Words
936     21
Critical Items
******************************************************************
                          INCORRECT TRIALS
 Words on List
1033    8
 Unrelated Words
1149    5
Critical Items
1045    5
```

```
subject = 191g5
                        CORRECT TRIALS
 Words on List
903      24
 Unrelated Words
995      25
Critical Items
1153     2
****************************************************************
                        INCORRECT TRIALS
 Words on List
1170     6
 Unrelated Words
980      5
Critical Items
703      2


subject = 192g5
                        CORRECT TRIALS
 Words on List
886      25
 Unrelated Words
869      29
Critical Items
****************************************************************
                        INCORRECT TRIALS
 Words on List
831      5
 Unrelated Words
1184     1
Critical Items
769      5


subject = 193g5
                        CORRECT TRIALS
 Words on List
982      22
 Unrelated Words
1159     28
Critical Items
****************************************************************
                        INCORRECT TRIALS
 Words on List
1367     7
 Unrelated Words
704      1
Critical Items
899      5


subject = 194g5
                        CORRECT TRIALS
 Words on List
770      18
 Unrelated Words
837      26
Critical Items
1016     1
****************************************************************
                        INCORRECT TRIALS
 Words on List
792      12
 Unrelated Words
779      4
Critical Items
731      4
```

```
subject = 195g5
                              CORRECT TRIALS
 Words on List
1418    25
 Unrelated Words
1482    27
Critical Items
1018    1
*****************************************************************
                             INCORRECT TRIALS
 Words on List
1427    2
 Unrelated Words
1385    1
Critical Items
1485    4


subject = 196g5
                              CORRECT TRIALS
 Words on List
827     25
 Unrelated Words
876     29
Critical Items
*****************************************************************
                             INCORRECT TRIALS
 Words on List
1050    5
 Unrelated Words
Critical Items
801     5


subject = 199g5
                              CORRECT TRIALS
 Words on List
914     24
 Unrelated Words
826     28
Critical Items
855     1
*****************************************************************
                             INCORRECT TRIALS
 Words on List
709     6
 Unrelated Words
1218    1
Critical Items
809     4


subject = 200g5
                              CORRECT TRIALS
 Words on List
970     19
 Unrelated Words
863     25
Critical Items
955     2
*****************************************************************
                             INCORRECT TRIALS
 Words on List
915     11
 Unrelated Words
861     4
 Critical Items
931     3
```

```
subject = 201g5
                          CORRECT TRIALS
 Words on List
843      27
 Unrelated Words
900      29
Critical Items
855      1
****************************************************************
                          INCORRECT TRIALS
 Words on List
1055     3
 Unrelated Words
Critical Items
782      4


subject = 202g5
                          CORRECT TRIALS
 Words on List
810      14
 Unrelated Words
943      16
Critical Items
922      2
****************************************************************
                          INCORRECT TRIALS
 Words on List
789      15
 Unrelated Words
668      12
Critical Items
768      3


subject = 203g5
                          CORRECT TRIALS
 Words on List
801      26
 Unrelated Words
900      27
Critical Items
****************************************************************
                          INCORRECT TRIALS
 Words on List
1125     4
 Unrelated Words
1287     2
Critical Items
754      5


subject = 204g5
                          CORRECT TRIALS
 Words on List
728      28
 Unrelated Words
778      29
Critical Items
788      1
****************************************************************
                          INCORRECT TRIALS
 Words on List
762      2
 Unrelated Words
Critical Items
750      4
```

```
subject = 205g5
                              CORRECT TRIALS
 Words on List
1031    25
 Unrelated Words
995     29
Critical Items
701     1
****************************************************************
                             INCORRECT TRIALS
 Words on List
1230    4
 Unrelated Words
Critical Items
966     4


subject = 206g5
                              CORRECT TRIALS
 Words on List
700     25
 Unrelated Words
865     27
Critical Items
862     2
****************************************************************
                             INCORRECT TRIALS
 Words on List
900     5
 Unrelated Words
821     2
Critical Items
726     3


subject = 207g5
                              CORRECT TRIALS
 Words on List
846     28
 Unrelated Words
776     28
Critical Items
****************************************************************
                             INCORRECT TRIALS
 Words on List
1377    2
 Unrelated Words
469     1
Critical Items
801     5


subject = 208g5
                              CORRECT TRIALS
 Words on List
823     25
 Unrelated Words
871     26
Critical Items
****************************************************************
                             INCORRECT TRIALS
 Words on List
1319    5
 Unrelated Words
925     3
754     1
 Critical Items
825     5
```

```
subject = 209g5
                            CORRECT TRIALS

 Words on List
1130    24
 Unrelated Words
1185    28
Critical Items
1314    3
******************************************************************
                            INCORRECT TRIALS

 Words on List
1393    5
 Unrelated Words
Critical Items
1254    2


subject = 210g5
                            CORRECT TRIALS

 Words on List
1047    29
 Unrelated Words
1198    21
Critical Items
******************************************************************
                            INCORRECT TRIALS

 Words on List
 Unrelated Words
1431    6
Critical Items
817     5


subject = 211g5
                            CORRECT TRIALS

 Words on List
1300    27
 Unrelated Words
901     29
Critical Items
855     1
******************************************************************
                            INCORRECT TRIALS

 Words on List
1462    3
 Unrelated Words
Critical Items
1399    4


subject = 212g5
                            CORRECT TRIALS

 Words on List
1300    22
 Unrelated Words
1161    26
Critical Items
******************************************************************
                            INCORRECT TRIALS

 Words on List
1462    5
 Unrelated Words
Critical Items
1399    5


subject = 213g5
                            CORRECT TRIALS

 Words on List
959     19
 Unrelated Words
812     27
Critical Items
801     1
******************************************************************
```

129

```
                              INCORRECT TRIALS
 Words on List
1015     11
 Unrelated Words
868      2
Critical Items
1022     4


subject = 214g5
                              CORRECT TRIALS
 Words on List
723      21
 Unrelated Words
792      25
Critical Items
*****************************************************************
                              INCORRECT TRIALS
 Words on List
845      8
 Unrelated Words
741      4
Critical Items
660      5


subject = 215g5
                              CORRECT TRIALS
 Words on List
991      20
 Unrelated Words
894      27
Critical Items
*****************************************************************
                              INCORRECT TRIALS
 Words on List
1152     10
 Unrelated Words
1184     1
Critical Items
837      5


subject = 216g5
                              CORRECT TRIALS
 Words on List
947      23
 Unrelated Words
928      27
Critical Items
*****************************************************************
                              INCORRECT TRIALS
 Words on List
1081     4
 Unrelated Words
939      1
Critical Items
875      5


subject = 217g5
                              CORRECT TRIALS
 Words on List
811      27
 Unrelated Words
858      28
Critical Items
*****************************************************************
                              INCORRECT TRIALS
 Words on List
838      2
 Unrelated Words
1100     1
Critical Items
730      5
```

```
subject = 218g5
                              CORRECT TRIALS
 Words on List
1360    20
 Unrelated Words
1138    23
Critical Items
1436     1
****************************************************************
                            INCORRECT TRIALS
 Words on List
1246    10
 Unrelated Words
1111     6
Critical Items
1326     4


subject = 219g5
                              CORRECT TRIALS
 Words on List
1194    21
 Unrelated Words
1587    23
Critical Items
1553     1
****************************************************************
                            INCORRECT TRIALS
 Words on List
1536     6
 Unrelated Words
1444     2
Critical Items
990      4


subject = 220g5
                              CORRECT TRIALS
 Words on List
956     23
 Unrelated Words
873     28
Critical Items
****************************************************************
                            INCORRECT TRIALS
 Words on List
1037     7
 Unrelated Words
Critical Items
702      5


subject = 221g5
                              CORRECT TRIALS
 Words on List
700     29
 Unrelated Words
706     28
Critical Items
960      2
****************************************************************
                            INCORRECT TRIALS
 Words on List
704      1
 Unrelated Words
553      1
Critical Items
824      3


subject = 222g5
                              CORRECT TRIALS
 Words on List
818     20
```

```
 Unrelated Words
841     23
Critical Items
1486    1
****************************************************************
                        INCORRECT TRIALS
 Words on List
898     10
 Unrelated Words
762     6
Critical Items
653     4


subject = 256g5
                        CORRECT TRIALS
 Words on List
884     21
 Unrelated Words
863     25
Critical Items
754     1
****************************************************************
                        INCORRECT TRIALS
 Words on List
846     8
 Unrelated Words
994     4
Critical Items
823     4


subject = 257g5
                        CORRECT TRIALS
 Words on List
789     26
 Unrelated Words
858     29
Critical Items
755     1
****************************************************************
                        INCORRECT TRIALS
 Words on List
1103    4
 Unrelated Words
Critical Items
624     4


subject = 258g5
                        CORRECT TRIALS
 Words on List
873     29
 Unrelated Words
1004    28
Critical Items
****************************************************************
                        INCORRECT TRIALS
 Words on List
1218    1
 Unrelated Words
900     1
Critical Items
878     4


subject = 259g5
                        CORRECT TRIALS
 Words on List
825     27
 Unrelated Words
791     28
Critical Items
855     1
****************************************************************
```

132

```
                              INCORRECT TRIALS
 Words on List
1085    3
 Unrelated Words
1100    1
Critical Items
745     4


subject = 260g5
                              CORRECT TRIALS
 Words on List
805     27
 Unrelated Words
907     28
Critical Items
******************************************************************
                              INCORRECT TRIALS
 Words on List
994     2
 Unrelated Words
1201    1
Critical Items
734     5
```

Dissertation Data: Group 6

```
subject = 223g6
                              CORRECT TRIALS
 Words on List
802     21
 Unrelated Words
825     29
Critical Items
700     1
******************************************************************
                              INCORRECT TRIALS
 Words on List
1011    9
 Unrelated Words
Critical Items
707     4


subject = 224g6
                              CORRECT· TRIALS
 Words on List
1025    26
 Unrelated Words
941     29
Critical Items
******************************************************************
                              INCORRECT TRIALS
 Words on List
885     4
 Unrelated Words
Critical Items
796     5


subject = 225g6
                              CORRECT TRIALS
 Words on List
870     26
 Unrelated Words
884     29
Critical Items
******************************************************************
                              INCORRECT TRIÁLS
 Words on List
1198    4
 Unrelated Words
Critical Items
791     5
```

```
subject = 226g6
                              CORRECT TRIALS
 Words on List
827      25
 Unrelated Words
797      28
Critical Items
707       1
*****************************************************************
                              INCORRECT TRIALS
 Words on List
908       5
 Unrelated Words
788       1
Critical Items
807       4


subject = 227g6
                              CORRECT TRIALS
 Words on List
932      26
 Unrelated Words
787      29
Critical Items
1167      2
*****************************************************************
                              INCORRECT TRIALS
 Words on List
941       4
 Unrelated Words
Critical Items
975       3


subject = 228g6
                              CORRECT TRIALS
 Words on List
764      24
 Unrelated Words
918      28
Critical Items
756       1
*****************************************************************
                              INCORRECT TRIALS
 Words on List
997       6
 Unrelated Words
1218      1
Critical Items
803       4


subject = 229g6
                              CORRECT TRIALS
 Words on List
923      28
 Unrelated Words
884      28
Critical Items
701       1
*****************************************************************
                              INCORRECT TRIALS
 Words on List
969       2
 Unrelated Words
687       1
Critical Items
716       4
```

```
subject = 230g6
                              CORRECT TRIALS

 Words on List
777      21
 Unrelated Words
831      21
Critical Items
***********************************************************
                              INCORRECT TRIALS

 Words on List
994      8
 Unrelated Words
819      7
Critical Items
699      4


subject = 231g6
                              CORRECT TRIALS

 Words on List
935      25
 Unrelated Words
818      29
Critical Items
1206      3
***********************************************************
                              INCORRECT TRIALS

 Words on List
1187     5
 Unrelated Words
Critical Items
1019     2


subject = 232g6
                              CORRECT TRIALS

 Words on List
1046     23
 Unrelated Words
1013     28
Critical Items
655      1
***********************************************************
                              INCORRECT TRIALS

 Words on List
1230     7
 Unrelated Words
Critical Items
745      4


subject = 233g6
                              CORRECT TRIALS

 Words on List
814      25
 Unrelated Words
781      28
Critical Items
819      2
***********************************************************
                              INCORRECT TRIALS

 Words on List
976      5
 Unrelated Words
1184     1
Critical Items
625      3
```

```
subject = 234g6
                              CORRECT TRIALS
 Words on List
876     20
 Unrelated Words
835     27
Critical Items
1033    1
*****************************************************************
                             INCORRECT TRIALS
 Words on List
1016    9
 Unrelated Words
860     2
Critical Items
691     4


subject = 235g6
                              CORRECT TRIALS
 Words on List
798     22
 Unrelated Words
939     23
Critical Items
838     1
*****************************************************************
                             INCORRECT TRIALS
 Words on List
858     7
 Unrelated Words
689     6
Critical Items
699     4


subject = 236g6
                              CORRECT TRIALS
 Words on List
815     24
 Unrelated Words
787     28
Critical Items
828     2
*****************************************************************
                             INCORRECT TRIALS
 Words on List
879     6
 Unrelated Words
737     1
Critical Items
631        3


subject = 237g6
                              CORRECT TRIALS
 Words on List
795     29
 Unrelated Words
856     25
Critical Items
667     1
*****************************************************************
                             INCORRECT TRIALS
 Words on List
989     1
 Unrelated Words
914     4
Critical Items
895     4
```

```
subject = 238g6
                              CORRECT TRIALS
 Words on List
700     23
 Unrelated Words
831     26
Critical Items
591     2
****************************************************************
                              INCORRECT TRIALS
 Words on List
837     7
 Unrelated Words
692     3
Critical Items
732     3


subject = 239g6
                              CORRECT TRIALS
 Words on List
815     27
 Unrelated Words
802     28
Critical Items
****************************************************************
                              INCORRECT TRIALS
 Words on List
986     3
 Unrelated Words
Critical Items
793     5


subject = 240g6
                              CORRECT TRIALS
 Words on List
776     24
 Unrelated Words
796     26
Critical Items
613     1
****************************************************************
                              INCORRECT TRIALS
 Words on List
803     6
 Unrelated Words
653     3
Critical Items
661     4


subject = 241g6
                              CORRECT TRIALS
 Words on List
897     26
 Unrelated Words
929     26
Critical Items
1196    2
****************************************************************
                              INCORRECT TRIALS
 Words on List
1002    4
 Unrelated Words
1187    2
 Critical Items
836     3


subject = 243g6
                              CORRECT TRIALS
 Words on List
950     9
 Unrelated Words
```

137

```
1036    5
Critical Items
******************************************************************
                           INCORRECT TRIALS
 Words on List
704     1
 Unrelated Words
952     4
Critical Items
1000    1


subject = 244g6
                            CORRECT TRIALS
 Words on List
1106    23
 Unrelated Words
988     26
Critical Items
******************************************************************
                           INCORRECT TRIALS
 Words on List
1222    5
 Unrelated Words
1023    3
Critical Items
1005    5


subject = 245g6
                            CORRECT TRIALS
 Words on List
1137    27
 Unrelated Words
1323    20
Critical Items
******************************************************************
                           INCORRECT TRIALS
 Words on List
1410    2
 Unrelated Words
1326    7
Critical Items
848     5


subject = 246g6
                            CORRECT TRIALS
 Words on List
778     26
 Unrelated Words
916     28
Critical Items
******************************************************************
                           INCORRECT TRIALS
 Words on List
1023    4
 Unrelated Words
721     1
Critical Items
790     5


subject = 247g6
                            CORRECT TRIALS
 Words on List
890     26
 Unrelated Words
938     28
Critical Items
******************************************************************
                           INCORRECT TRIALS
 Words on List
1027    4
```

```
 Unrelated Words
1020    1
Critical Items
806     4


subject = 248g6
                              CORRECT TRIALS
 Words on List
910     27
 Unrelated Words
945     28
Critical Items
***************************************************************
                             INCORRECT TRIALS
 Words on List
1135    3
 Unrelated Words
1050    1
Critical Items
821     4


subject = 249g6
                              CORRECT TRIALS
 Words on List
809     26
 Unrelated Words
1034    24
Critical Items
755     1
***************************************************************
                             INCORRECT TRIALS
 Words on List
937     4
 Unrelated Words
995     5
Critical Items
782     4


subject = 250g6
                              CORRECT TRIALS
 Words on List
834     16
 Unrelated Words
826     26
Critical Items
935     2
***************************************************************
                             INCORRECT TRIALS
 Words on List
899     13
 Unrelated Words
832     3
Critical Items
670     3


subject = 251g6
                              CORRECT TRIALS
 Words on List
893     24
 Unrelated Words
852     29
Critical Items
1544    2
***************************************************************
                             INCORRECT TRIALS
 Words on List
1131    5
 Unrelated Words
Critical Items
776     3
```

```
subject = 252g6
                              CORRECT TRIALS
 Words on List
881     23
 Unrelated Words
971     27
Critical Items
*****************************************************************
                              INCORRECT TRIALS
 Words on List
1101    4
 Unrelated Words
1218    1
Critical Items
860     5


subject = 253g6
                              CORRECT TRIALS
 Words on List
956     21
 Unrelated Words
1062    27
Critical Items
655     1
*****************************************************************
                              INCORRECT TRIALS
 Words on List
993     5
 Unrelated Words
Critical Items
920     3


 subject = 254g6
                              CORRECT TRIALS
 Words on List
871     28
 Unrelated Words
1043    29
Critical Items
*****************************************************************
                              INCORRECT TRIALS
 Words on List
1237    2
 Unrelated Words
Critical Items
782     4


subject = 256g6
                              CORRECT TRIALS
 Words on List
885     27
 Unrelated Words
841     29
Critical Items
1018    2
*****************************************************************
                              INCORRECT TRIALS
 Words on List
 970    3
 Unrelated Words
Critical Items
1048    3
```

```
subject = 153g7
                              CORRECT TRIALS
 Words on List
720      18
 Unrelated Words
732      28
Critical Items
*****************************************************************
                              INCORRECT TRIALS
 Words on List
895      11
 Unrelated Words
796       2
Critical Items
690       5


suject = 154g7
                              CORRECT TRIALS
 Words on List
851      26
 Unrelated Words
893      27
Critical Items
*****************************************************************
                              INCORRECT TRIALS
 Words on List
936       3
 Unrelated Words
864       3
Critical Items
719       5


subject = 155g7
                              CORRECT TRIALS
 Words on List
900      26
 Unrelated Words
876      25
Critical Items
1519      1
*****************************************************************
                              INCORRECT TRIALS
 Words on List
1620      1
 Unrelated Words
952       2
Critical Items
998       3


subject = 156g7
                              CORRECT TRIALS
 Words on List
778      23
 Unrelated Words
816      26
Critical Items
*****************************************************************
                              INCORRECT TRIALS
 Words on List
877       6
 Unrelated Words
720       4
Critical Items
620       5
```

141

```
subject = 157g7
                              CORRECT TRIALS
 Words on List
830     23
 Unrelated Words
801     24
Critical Items
*************************************************************
                              INCORRECT TRIALS
 Words on List
872     1
 Unrelated Words
986     2
 Critical Items
726     4

subject = 161g7
                              CORRECT TRIALS
 Words on List
865     21
 Unrelated Words
892     29
Critical Items
*************************************************************
                              INCORRECT TRIALS
 Words on List
880     8
 Unrelated Words
721     1
Critical Items
787     5

subject = 162g7
                              CORRECT TRIALS
 Words on List
782     23
 Unrelated Words
855     27
Critical Items
*************************************************************
                              INCORRECT TRIALS
 Words on List
1001    6
 Unrelated Words
908     3
Critical Items
684     5

subject = 163g7
                              CORRECT TRIALS
 Words on List
844     26
 Unrelated Words
831     27
Critical Items
*************************************************************
                              INCORRECT TRIALS
 Words on List
815     3
 Unrelated Words
973     3
Critical Items
813     5

subject = 164g7
                              CORRECT TRIALS
 Words on List
1148    22
 Unrelated Words
1188    28
Critical Items
```

142

```
1586    2
****************************************************************
                        INCORRECT TRIALS
 Words on List
1187    7
 Unrelated Words
1145    2
Critical Items
1230    3


subject = 165g7
                        CORRECT TRIALS
 Words on List
780     25
 Unrelated Words
764     29
Critical Items
****************************************************************
                        INCORRECT TRIALS
 Words on List
952     4
 Unrelated Words
1000    1
Critical Items
657     5


subject = 167g7
                        CORRECT TRIALS
 Words on List
638     25
 Unrelated Words
738     24
Critical Items
****************************************************************
                        INCORRECT TRIALS
 Words on List
845     4
 Unrelated Words
656     6
Critical Items
604     5


subject = 168g7
                        CORRECT TRIALS
 Words on List
765     22
 Unrelated Words
831     27
Critical Items
****************************************************************
                        INCORRECT TRIALS
 Words on List
799     6
 Unrelated Words
869     3
Critical Items
657     5


subject = 169g7
                        CORRECT TRIALS
 Words on List
1173    20
 Unrelated Words
1029    26
Critical Items
1134    1
****************************************************************
                        INCORRECT TRIALS
 Words on List
879     4
 Unrelated Words
```

```
1199    2
Critical Items
898     4


subject = 170g7
                              CORRECT TRIALS
 Words on List
1090    25
 Unrelated Words
1003    26
Critical Items
1631    3
*****************************************************************
                              INCORRECT TRIALS
 Words on List
1040    3
 Unrelated Words
1625    3
Critical Items
612     2


subject = 171g7
                              CORRECT TRIALS
 Words on List
849     23
 Unrelated Words
837     26
Critical Items
922     1
*****************************************************************
                              INCORRECT TRIALS
 Words on List
979     5
 Unrelated Words
1024    3
Critical Items
989     4


subject = 172g7
                              CORRECT TRIALS
 Words on List
996     19
 Unrelated Words
1109    24
Critical Items
1184    1
*****************************************************************
                              INCORRECT TRIALS
 Words on List
822     5
 Unrelated Words
1195    4
Critical Items
958     4


subject = 173g7
                              CORRECT TRIALS
 Words on List
743     22
 Unrelated Words
791     28
Critical Items
586     1
*****************************************************************
                              INCORRECT TRIALS
 Words on List
946     6
 Unrelated Words
695     2
Critical Items
607     4
```

```
subject = 174g7
                         CORRECT TRIALS
 Words on List
860     27
 Unrelated Words
763     25
Critical Items
*****************************************************************
                         INCORRECT TRIALS
 Words on List
893     2
 Unrelated Words
871     5
Critical Items
767     5


subject = 175g7
                         CORRECT TRIALS
 Words on List
699     29
 Unrelated Words
740     27
Critical Items
*****************************************************************
                         INCORRECT TRIALS
 Words on List
 Unrelated Words
936     3
Critical Items
697     5


subject = 176g7
                         CORRECT TRIALS
 Words on List
882     21
 Unrelated Words
913     28
Critical Items
*****************************************************************
                         INCORRECT TRIALS
 Words on List
911     8
 Unrelated Words
930     2
Critical Items
729     5


subject = 177g7
                         CORRECT TRIALS
 Words on List
904     20
 Unrelated Words
1122    22
Critical Items
704     1
*****************************************************************
                         INCORRECT TRIALS
 Words on List
 1036    9
 Unrelated Words
937     8
Critical Items
746     4


subject = 178g7
                         CORRECT TRIALS
 Words on List
918     25
 Unrelated Words
1019    25
Critical Items
```

```
*****************************************************************
                        INCORRECT TRIALS
 Words on List
1288    4
 Unrelated Words
1043    4
Critical Items
820     5


subject = 179g7
                        CORRECT TRIALS
 Words on List
743     24
 Unrelated Words
731     25
Critical Items
*****************************************************************
                        INCORRECT TRIALS
 Words on List
763     5
 Unrelated Words
803     5
Critical Items
677     5


subject = 180g7
                        CORRECT TRIALS
 Words on List
997     23
 Unrelated Words
864     26
Critical Items
855     2
*****************************************************************
                        INCORRECT TRIALS
 Words on List
1403    6
 Unrelated Words
943     4
Critical Items
975     3


subject = 181g7
                        CORRECT TRIALS
 Words on List
1024    21
 Unrelated Words
1068    27
Critical Items
1167    1
*****************************************************************
                        INCORRECT TRIALS
 Words on List
1352    2
 Unrelated Words
1135    3
Critical Items
1297    4


subject = 182g7
                        CORRECT TRIALS
 Words on List
841     23
 Unrelated Words
832     27
Critical Items
*****************************************************************
                        INCORRECT TRIALS
 Words on List
921     6
```

```
 Unrelated Words
841      3
Critical Items
703      5


subject = 183g7
                             CORRECT TRIALS

 Words on List
724     26
 Unrelated Words
755     26
Critical Items
**************************************************************
                            INCORRECT TRIALS
 Words on List
832      3
 Unrelated Words
766      4
Critical Items
646      5


subject = 184g7
                             CORRECT TRIALS

 Words on List
1394    23
 Unrelated Words
1126    25
Critical Items
1352     1
**************************************************************
                            INCORRECT TRIALS
 Words on List
1470     6
 Unrelated Words
1556     5
Critical Items
1355     4


subject = 185g7
                             CORRECT TRIALS

 Words on List
1139    19
 Unrelated Words
1259    23
Critical Items
301      1
**************************************************************
                            INCORRECT TRIALS
 Words on List
1575     9
 Unrelated Words
1460     2
Critical Items
928      4


subject = 187g7
                             CORRECT TRIALS

 Words on List
1205    26
 Unrelated Words
1295    24
Critical Items
**************************************************************
                            INCORRECT TRIALS
 Words on List
 Unrelated Words
1301     1
Critical Items
1428     4
```

147

```
subject = 124g8
                            CORRECT TRIALS
 Words on List
895      24
 Unrelated Words
921      26
 Critical Items
705      1
********************************************************************
                            INCORRECT TRIALS
 Words on List
1216     5
 Unrelated Words
907      4
Critical Items
748      4


subject = 125g8
                            CORRECT TRIALS
 Words on List
848      21
 Unrelated Words
924      26
Critical Items
********************************************************************
                            INCORRECT TRIALS
 Words on List
1216     7
 Unrelated Words
854      4
Critical Items
1213     5


subject = 126g8
                            CORRECT TRIALS
 Words on List
727      26
 Unrelated Words
837      26
Critical Items
********************************************************************
                            INCORRECT TRIALS
 Words on List
858      3
 Unrelated Words
852      3
Critical Items
750      5


subject = 127g8
                            CORRECT TRIALS
 Words on List
896      6
 Unrelated Words
765      3
Critical Items
813      5
********************************************************************
                            INCORRECT TRIALS
 Words on List
845      20
 Unrelated Words
812      27
Critical Items
```

```
subject = 128g8
                            CORRECT TRIALS
 Words on List
1071    24
 Unrelated Words
1121    26
Critical Items
*****************************************************************
                            INCORRECT TRIALS
 Words on List
1161    5
 Unrelated Words
1277    4
Critical Items
913     5


subject = 129g8
                            CORRECT TRIALS
 Words on List
1072    20
 Unrelated Words
1164    28
Critical Items
1519    1
*****************************************************************
                            INCORRECT TRIALS
 Words on List
1387    7
 Unrelated Words
905     2
Critical Items
953     4


subject = 130g8
                            CORRECT TRIALS
 Words on List
844     27
 Unrelated Words
837     25
Critical Items
*****************************************************************
                            INCORRECT TRIALS
 Words on List
922     1
 Unrelated Words
730     5
Critical Items
834     5


subject = 131g8
                            CORRECT TRIALS
 Words on List
1097    25
 Unrelated Words
1252    27
Critical Items
1855    2
*****************************************************************
                            INCORRECT TRIALS
 Words on List
1335    3
 Unrelated Words
1132    3
Critical Items
1259    2
```

```
subject = 132g8
                              CORRECT TRIALS
 Words on List
768      26
 Unrelated Words
824      25
Critical Items
*****************************************************************
                              INCORRECT TRIALS
 Words on List
838      2
 Unrelated Words
878      5
Critical Items
803      5


subject = 133g8
                              CORRECT TRIALS
 Words on List
821      23
 Unrelated Words
877      21
Critical Items
1083     1
*****************************************************************
                              INCORRECT TRIALS
 Words on List
1082     6
 Unrelated Words
865      9
Critical Items
779      4


subject = 134g8
                              CORRECT TRIALS
 Words on List
886      23
 Unrelated Words
912      24
Critical Items
655      1
*****************************************************************
                              INCORRECT TRIALS
 Words on List
929      6
 Unrelated Words
1311     6
Critical Items
870      4


subject = 135g8
                              CORRECT TRIALS
 Words on List
758      27
 Unrelated Words
1019     21
Critical Items
*****************************************************************
                              INCORRECT TRIALS
 Words on List
830      2
 Unrelated Words
797      9
Critical Items
687      5


subject = 136g8
                              CORRECT TRIALS
 Words on List
1299     18
 Unrelated Words
```

```
1570    14
Critical Items
1182    2
****************************************************************
                        INCORRECT TRIALS
 Words on List
1462    12
 Unrelated Words
1230    6
Critical Items
1316    2


subject = 137g8
                        CORRECT TRIALS
 Words on List
870     24
 Unrelated Words
889     26
Critical Items
637     2
****************************************************************
                        INCORRECT TRIALS
 Words on List
1216    5
 Unrelated Words
832     4
Critical Items
641     3


subject = 138g8
                        CORRECT TRIALS
 Words on List
1113    23
 Unrelated Words
992     26
Critical Items
655     1
****************************************************************
                        INCORRECT TRIALS
 Words on List
1284    2
 Unrelated Words
986     2
Critical Items
903     4


subject = 139g8
                        CORRECT TRIALS
 Words on List
920     22
 Unrelated Words
909     28
Critical Items
718     2
****************************************************************
                        INCORRECT TRIALS
 Words on List
1070    7
 Unrelated Words
1028    2
Critical Items
771     3


subject = 140g8
                        CORRECT TRIALS
 Words on List
875     26
 Unrelated Words
846     28
Critical Items
1503    1
```

151

```
*****************************************************************
                         INCORRECT TRIALS
 Words on List
1029    3
 Unrelated Words
880     2
Critical Items
657     4


subject = 141g8
                         CORRECT TRIALS
 Words on List
830     24
 Unrelated Words
916     26
Critical Items
*****************************************************************
                         INCORRECT TRIALS
 Words on List
895     5
 Unrelated Words
1026    3
Critical Items
754     5


subject = 142g8
                         CORRECT TRIALS
 Words on List
935     20
 Unrelated Words
968     26
Critical Items
655     1
*****************************************************************
                         INCORRECT TRIALS
 Words on List
988     9
 Unrelated Words
1103    4
Critical Items
828     4


subject = 143g8
                         CORRECT TRIALS
 Words on List
1380    21
 Unrelated Words
1699    8
Critical Items
*****************************************************************
                         INCORRECT TRIALS
 Words on List
792      9
 Unrelated Words
1692    3
Critical Items
436     2


subject = 144g8
                         CORRECT TRIALS
 Words on List
811     25
 Unrelated Words
808     26
Critical Items
*****************************************************************
                         INCORRECT TRIALS
 Words on List
800     4
 Unrelated Words
787     4
```

```
Critical Items
757      5


subject = 145g8
                                    CORRECT TRIALS
 Words on List
956     20
 Unrelated Words
886     27
Critical Items
1134    1
***************************************************************
                                    INCORRECT TRIALS
 Words on List
1001    8
 Unrelated Words
1179    2
Critical Items
916      3


subject = 146g8
                                    CORRECT TRIALS
 Words on List
833     29
 Unrelated Words
749     22
Critical Items
***************************************************************
                                    INCORRECT TRIALS
 Words on List
 Unrelated Words
692      3
Critical Items
552      5


subject = 148g8
                                    CORRECT TRIALS
 Words on List
759     26
 Unrelated Words
816     27
Critical Items
654      1
***************************************************************
                                    INCORRECT TRIALS
 Words on List
959      3
 Unrelated Words
914      3
Critical Items
771      4


subject = 149g8
                                    CORRECT TRIALS
 Words on List
818     22
 Unrelated Words
900     26
Critical Items
556      1
***************************************************************
                                    INCORRECT TRIALS
 Words on List
1259    7
 Unrelated Words
886      4
Critical Items
868      4
```

153

```
subject = 150g8
                              CORRECT TRIALS
 Words on List
996      25
 Unrelated Words
1120     28
Critical Items
*******************************************************************
                              INCORRECT TRIALS
 Words on List
1041     3
 Unrelated Words
1061     2
Critical Items
770      5


subject = 151g8
                              CORRECT TRIALS
 Words on List
803      25
 Unrelated Words
881      27
Critical Items
*******************************************************************
                              INCORRECT TRIALS
 Words on List
920      4
 Unrelated Words
1024     3
Critical Items
710      5


subject = 152g8
                              CORRECT TRIALS
 Words on List
832      25
 Unrelated Words
1006     15
Critical Items
*******************************************************************
                              INCORRECT TRIALS
 Words on List
958      3
 Unrelated Words
816      14
Critical Items
707      5


subject = 158g8
                              CORRECT TRIALS
 Words on List
857      24
 Unrelated Words
853      28
Critical Items
*******************************************************************
                              INCORRECT TRIALS
 Words on List
989      5
 Unrelated Words
855      2
Critical Items
690      5


subject = 159g8
                              CORRECT TRIALS
 Words on List
981      28
 Unrelated Words
911      27
Critical Items
```

154

```
****************************************************************
                        INCORRECT TRIALS
 Words on List
1385      1
 Unrelated Words
1079      3
Critical Items
966       5


subject = 160g8
                        CORRECT TRIALS
 Words on List
948       27
 Unrelated Words
1345      23
Critical Items
1939      1
****************************************************************
                        INCORRECT TRIALS
 Words on List
1103      2
 Unrelated Words
1111      4
Critical Items
748       4
```

APPENDIX C

IRB APPROVAL FORM

**Oklahoma State University
Institutional Review Board**

Protocol Expires: 2/10/03

Date: Monday, February 11, 2002   IRB Application No   AS0239

Proposal Title: EFFECT OF SEMANTIC VARIABLES AND DEPTH OF PROCESSING ON THE
PRODUCTION OF FALSE MEMORIES

Principal
Investigator(s):

Blaine Browne   Charles Abramson
401 N Murray   401 N Murray
Stillwater, OK 74078   Stillwater, OK 74078

Reviewed and
Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

Dear PI :

Your IRB application referenced above has been approved for one calendar year. Please make note of the expiration date indicated above. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved projects are subject to monitoring by the IRB. If you have questions about the IRB procedures or need any assistance from the Board, please contact Sharon Bacher, the Executive Secretary to the IRB, in 203 Whitehurst (phone: 405-744-5700, sbacher@okstate.edu).

Sincerely,

Carol Olson, Chair
Institutional Review Board

VITA $\mathcal{2}$

Blaine L. Browne

Candidate for the Degree of

Doctor of Philosophy

Thesis: EXAMINATION OF FALSE RECALL AND RECOGNITION
USING THE DRM PARADIGM

Major Field: Psychology

Biographical:

Education: Received Bachelor of Arts degree in Psychology from Florida State
University, Tallahassee, Florida in may 1992. Received Master of Arts
degree in Psychology from University of Central Oklahoma, Edmond,
Oklahoma in May 1996. Received Master of Science degree in Psychology
from Oklahoma State University in May 2001. Completed the requirements
for the Doctor of Philosophy degree with a major in Psychology at
Oklahoma State University in August 2002.

Experience: Employed by Oklahoma State University Department of Psychology
as an instructor and research assistant from 1997 to 2002.

Professional Memberships: American Psychological Society, Southwest
Psychological Association, Oklahoma Psychological Society.