

Paired-Associate Learning

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Abstract

The present study evaluated an important variable in neuropsychology, which is the impact of patient emotional associations to verbal stimuli during memory testing. Accurate and detailed memory testing is vital to the diagnosis and treatment of neuropathology (e.g. traumatic brain injury). Students were asked to learn a series of word pairs that varied in emotional valence: positive (happy—merry), negative (slay—murder), and neutral or original (curtains—blinds). A one-way repeated-measures ANOVA illustrated a significant effect of emotional valence [$F(2) = 14.5, p < 0.001$], with recall for the neutral/original word pairs ($M = 8.3$) being significantly greater than recall for the negative ($M = 5.4$) and positive ($M = 5.13$) word pairs. Since the emotional (negative or positive) word pairs were synonyms, they could have been more difficult to recall than the neutral/original word pairs. The neutral/original word pairs may also have been higher in imagery than the emotional word pairs. Implications for future research will be discussed.

Paired-Associate Learning

Research in the area of learning and memory has rapidly expanded during the last few decades. Researchers now have access to an extensive body of knowledge about the use of mnemonic devices or associations between semantically related words. The present study used an exploratory technique to evaluate the use of semantically associated words in relation to learning and memory. The present study focused on paired associative memory, which is an important neuropsychology issue in which emotional associations to verbal stimuli are tested for better understanding of cognitive processes. Emotional valence effect on memory and learning is also of great importance for the area of neuropsychology. This study is also specifically relevant to the improvement and understanding of college learning. It was hypothesized that emotional valence will have an effect on memory and learning, and the negative words would be recalled more frequently than positive or neutral/original words. However, the findings partially support this hypothesis. The neutral/original word pairs were recalled more frequently than either the negative or positive word pairs, a result attributed to the higher imagery of the neutral/original pair words.

After numerous studies, scientists are able to identify the areas of the brain associated with memory. The structures involved in learning and memory include the

temporal lobe, the parietal cortex, the hippocampus, and the limbic cortex. Reas and Brewer (2013) articulate that “[b]rain regions sensitive to the strength of the retrieved memory include areas of the medial temporal lobe” (p. 219). Reas and Brewer also add that the “parietal cortex is known to serve an essential role in visuospatial attention, working memory, and sensory association [citations omitted] , [and] parietal subregions are also engaged during memory retrieval” (p. 229). The hippocampus with the collaboration of closely related structures is responsible for the majority of cognitive processes. Carlson (2011) state the following: “the hippocampal formation and the limbic cortex of the medial temporal lobe appear to be involved in the consolidation and retrieval of declarative memories, both episodic and semantic” (p. 366). Furthermore, Norman, Newman, & Detre (2007) observe that

the job of the hippocampal network is to rapidly memorize patterns of cortical activity in a manner that supports pattern completion (i.e., retrieval of the entire pattern in response to a partial cue) after a single study exposure to the pattern. (p. 895)

The hippocampal network supports the task of memorization and learning, thus enabling the process of learning as well as various cognitive processes.

Research on the dual-coding theory has generated valuable knowledge in the area of cognitive psychology. Crawford and Allen (1996) note that Paivio presented the dual-coding theory in his earlier studies (p.355). Crawford and Allen (1996) refer to “Paivio’s (1971, 1986, 1989) dual-coding theory that proposes that there are functionally separate but interactive imaginal and verbal processing systems operating during the recall of pictorial and verbal stimuli” (p. 355). Highly visual imagery generates vivid images that enhance the participant’s ability to learn and to remember. Hence, an individual can vividly conceive high imagery words, both verbally and imaginably. According to the dual-coding theory, both visual and verbal information are processed individually but not independently of each other. Crawford and Allen (1996) explain that “imaginal processes assist in the learning and recall of high imagery words” (p. 355). Perhaps high imagery allows an individual to become more involved and to experience the meaning of a word to a greater level, thus facilitating and improving memory.

Recent research has focused on dual-process theory providing knowledge about specific areas of the brain involved with it. A study by Hayes, Buchler, Stokes, Kragel, and Cabeza (2011) suggests that “[d]ual-process theories have proposed that familiarity is more dependent on rhinal cortex whereas recollection is more dependent on the hippocampus” (p. 3959). The dual-process theory suggests that the method of memorization depends on the familiarity of the word being recalled. Different structures are used for the different methods of memorization and learning. But it is the familiarity of the item that reinforces the method used by the brain.

While high imagery is considered a very influential factor in paired-associate learning, other factors should also be taken into consideration. For instance, attention and motivation to learn a specific task are also significant aspects. Campbell, Trelle, and Hasher (2013) indicate that “learning a list of word pairs requires one to limit attention” (p. 5). Hence, learning any task depends, to a certain extent, on the attention of the person. Reas and Brewer (2013) identify attention as a necessary condition for memory.

Additionally, Reas and Brewer (2013) note the following: “cognitive control and attention critically contribute to episodic memory retrieval efforts and success” (p. 219). Furthermore, the level of motivation is believed to play a significant role in cognitive processes. In their study, Wolosin, Zeithamova, and Preston (2012) argue the following: “distributed patterns of activation within human hippocampus differentiate between motivational contexts during motivated learning to support encoding of novel information” (p. 1272). Similarly, studies with rodents suggest that hippocampal activity in rodents is closely correlated with motivation (Wolosin, Zeithamova, & Preston, 2012, p. 1272).

This Paired-Associate Learning study looks at pair associative learning, which has been a focus of research during the last few decades. Pair associative learning binds different terms or concepts together for the purpose of improved memory. Pengyun, Juan, Huijie, and Shouzi (2013) explain that “associative memory requires remembering of the relationship between items, such as pairs of words” (p. 2). Moreover, remembering newly associated pairs comprise what Pengyun, Juan, Huijie, and Shouzi called a double process. In their study, Pengyun, Juan, Huijie, and Shouzi (2013) state the two processes as follows: “One is acquiring items that have not yet been learned well enough to be retrieved. The other is consolidating items that have already been acquired” (p. 2). Therefore, the individual has to first recognize and encode the information acquired, which in this case would be the word pair. Second, the individual has to be able to reclaim and restate the information, which in this case includes restating and identifying the missing word once presented with one of the words in the pair.

For emotional valence assessment, semantically related words were selected from the list of words earlier developed by Toggia and his colleagues. Semantically related words have been categorized after extensive research. According to Toggia (2009), Paivio, Yuille, and Madigan were the pioneers in semantic words categorization; they were responsible for the primary classification of emotionally related words (p. 531). Toggia (2009) points out the following: “prior to our 1978 norms, a major option was the normative work of Paivio, Yuille, and Madigan (1968). Their norms were, and remain, very useful, but they were limited to 925 items—all nouns—and three scaled dimensions” (p.531). Furthermore, in 1978 Paivio’s findings were expanded and developed to a larger list of words. Toggia (2009) refers to the new norms as the “Toggia and Battig norms” that “expanded the rating of verbal items to include many parts of speech and provided data on seven verbal characteristics: imagery, concreteness, meaningfulness, familiarity, number of attributes, categorizability, and pleasantness” (p. 531). Such findings are used in the present study to evaluate learning as a function of emotional valence. The emotional valence word pairs included negative word pairs (slay—murder), positive word pairs (happy—merry), and neutral or original word pairs (curtains—blinds).

Sadalla and Loftness (1972) conducted a research study in which participants were instructed to create images with emotional words to assess paired-associate learning. Similarly to the current study, Sadalla and Loftness (1972) used paired words from the Paivio, Yuille, and Madigan word list (p.295). The participants were given instructions as to how to associate the emotional words and how to employ mnemonic strategies with the different emotional words. Different instructions were given for each

of the three different emotional valence conditions, which included a neutral condition, a positive, and a negative condition. Sadalla and Loftness (1972) found that “instructions to create ‘emotional’ associations lead to the construction of a sequence of cognitive elaborations which are later recalled more easily and with greater rated clarity” (p. 297). The results of Sadalla and Loftness suggest that the use of mnemonic strategies facilitates paired-associate learning. However, the likelihood of participants using a mnemonic device without prior instructions is undetermined.

A recent study by Pierce and Kensinger (2011) describe that “there may be special mechanisms at work when information is both high in arousal and also negative in valence” (p. 141). However, Pierce and Kensinger (2011) did not take into consideration the level of imagery of the word pairs. Their study asked students from a university setting to identify pairs of words that were either intact, arranged into new pairs, or were a new pair (a pair that the participants were not previously exposed to). Pierce and Kensinger (2011) considered factors such as familiarity, frequency, concreteness, and imageability (p. 140). Pierce and Kensinger took an interesting approach; they instructed the participants to associate the words by quietly forming a sentence that included both words. They also instructed the participants to rate the difficulty of the task as the sentence was elaborated. They did not take into consideration the time it took for the participants to identify or recall the correct response. However, between the administrations of conditions, an interval of 15 minutes was used to complete a maze task in order to distract the participants. In their study, Pierce and Kensinger (2011) report that “Negative valence has been shown to restrict attention to local features while positive valence has been shown to broaden attention and to encourage more global processing” (p. 141). Thus, valence has been shown to influence the learning ability.

In a different study, the contribution of mnemonic strategies and motivation to learn in paired-associate learning was evaluated (Duplessis, Hiscock, and McMurray, 1981). Duplessis, Hiscock, and McMurray’s study focused in incidental learning, intentional learning, and intentional learning with incentive to learn. Participants from the experimental group received instructions to associate high imagery pairs. Duplessis, Hiscock, and McMurray (1981) found that “mnemonics instructions have a facilitative effect in PAL performance” (p. 64). Contrary to the study discussed previously, Duplessis, Hiscock, and McMurray compare paired-associate learning with a control group. The control group did not receive any instructions as to using a mnemonic device. The results of the control group and the experimental group highly differ, suggesting that associative learning has a great impact in memory.

Precise and detailed memory assessment is vital to the diagnosis and treatments in neuropathology. Experimental studies expand the knowledge of neuropsychological areas and also improve diagnosis, testing and treatment of neurological disorders. This study is intended to strengthen the understanding of cognitive processes. The approach is to explore the effects of emotional valence on memory. The present study paired semantically related words (positive, negative, and neutral/original). The semantically related words were further labeled into either high or low imagery word pairs to assess memory and learning. The study focuses on conducting an exploratory analysis in paired-associate learning as a function of emotional valence. The approach followed here includes the use of the emotional words to assess whether recall of the words could

be disturbed. It is hypothesized that emotional valence (positive, negative, or neutral) will have an effect in the recall of pair associated words (high imagery, low imagery). Additionally, it is anticipated that the negative words will have a higher recall than the positive or neutral word pairs.

Methods

Participants

Participants for the study were recruited from General Psychology day classes of Methodist University. The researcher gathered data from about 10 participants. Participant age ranged from 18-25. Sexual orientation was not taken into consideration. Participants were given extra credit for participating in the study. All participants were given the option to withdraw, if necessary or uncomfortable, at any time during the experiment.

Apparatus

The study was conducted in a small psychology experiment room where the experimenter assured the comfort of all participants. Both participants and researcher sat around a small table about one to two feet apart and facing each other. Participants were instructed to sit in a comfortable chair in the silent experiment room. The researcher presented the participants with pair words. The pair words presented to the participants consisted of block printed capital letters, written on 4" x 6" index cards. The note cards were randomly arranged and kept under the same arrangement throughout the duration of the study so that the same order was presented to each participant. The notecards were placed in the middle of the table to provide a barrier between the participant and the experimenter. Notecards were presented to all participants in the same manner.

The words chosen included 30 pairs of words. The words had been categorized and selected based on their emotional meaning, which included neutral (or original), negative, or positive. There was also a set of 10 pairs of filler words; five were presented at the beginning of the 30 emotional pair words, and five were presented at the end of the 30 emotional pair words. The emotional words such as positive and negative were selected from the semantic word norms of Toggia and Battig (1978), which were established after "examination of the number of citations of this set of norms over the years" and which show "a stable employment of these norms by investigators in many fields" (p. 531). The neutral words were obtained from the Rey Auditory Verbal Learning Test, which "simultaneously provides several measures of learning and memory" (Vakil and Blachstein, 1993).

Design

The present study used a 2 (High Imagery, Low Imagery) by 3 (positive, negative, neutral) repeated measures factorial within participants ANOVA. The number of pair words recalled correctly by the participants constituted the dependent measure.

Procedure

After welcoming the participants and closing the door for privacy and to prevent any possible interruption, the researcher proceeded with the informed consent form (refer to Appendix 1). The researcher then instructed the participants as quoted from Pavio (1983):

In front of me I have a set of cards. On each card there are two nouns, such as “table” and “coffee”. Your task is to learn that these two nouns are paired together so that when, at a later time, I give you another that only has “table” on it you can recall the word “coffee” and say it to me. I will then write down your response. The procedure I will follow is this: First, I will give you a series of different cards, each for 10 seconds. On each card will be two words. You are to learn that these two words are paired together. After we complete this set of cards, I will turn to a second pile of cards in front of me. I will show you one card at the time for 10 seconds. During that time you are to tell me what word you think was associated with it. Always guess even if you cannot remember the associated word. Do not leave any blank. Are there any questions? (p. 88).

If the participants had questions, the researcher repeated the instructions. The experimenter was then to continue, presenting the participant with one stimulus card at a time, for 10 seconds each. Each stimulus card was presented to the participant so that it was easily readable, until the total of 40 cards was reached. Then the experimenter turned to the second pile and said to the participant: “Now I will present one of the two pairs of words. Tell me within the 10 second period what the associated word is. If you are not sure, you must guess” (Pavio 1983). The experimenter then continued to present the second pile of words, each for a period of 10 seconds. The researcher wrote down the participant’s responses. The second pile of words did not include the filler words. Thus the experimenter recorded only a total of 30 words. After completing this portion of the experiment, the experimenter asked the participants to write down the method or methods they used to learn and recall the words. The experimenter then debriefed the participants as to the purpose of the experiment (Pavio, 1983).

Results

A one-way Analysis of Variance (ANOVA) was performed on the dependent variable, which was the number of words correctly recalled. A statistically significant effect of emotional valence for the words was found ($F^2=14.5$ $p<0.001$). Post-hoc (HSD) analysis revealed that participants recalled significantly more neutral words ($M=8.3$), than either the positive words ($M=5.13$) or the negative words ($M=5.4$).

Discussion

The present study anticipated that participants would recall more negative word pairs. However, only partial support for the hypothesis was obtained. Unlike the hypothesis projected, there was no effect of the positive or negative word pairs. Recall for the emotionally neutral words was greater, possibly due to the higher imagery. One of the studies relating to high imagery words shows the following: “Highly imageable words are learned more readily and are recalled more often and with greater consistency than words that are more difficult to image” (Weingartner, Caine, & Ebert, 1979, p. 53). Therefore, the complexity of high imagery words must require a higher level of involvement by the brain, which may account for the high frequency of high imagery words recalled. In their study, Weingartner, Caine, and Ebert (1979) suggest that the brain creates a binding reaction to process the high imagery words, in which the information is “dually coded (visual and verbal representation in memory)” (p. 54).

Neurological studies suggest that areas of the brain responsible for memory and visual imagery are closely interrelated. For instance, “visual memory and visual mental imagery are mediated by many of the same cognitive processes. In spite of the observed differences, we also found some similar patterns of neural results in the two tasks” (Slotnick, Thompson & Kosslyn, 2012, p. 20). Hence, the association of high imagery words is processed by more than one area in the brain. The findings of Slotnick, Thompson, and Kosslyn (2012) confirmed the following: “visual memory and visual mental imagery rely on the same frontal-parietal control regions and occipital-temporal sensory regions” (p. 19). Thus, the same areas of the brain processed high imagery words, but the process does not employ identical methods. These findings suggest that cognitive processes reinforce each other, facilitating memory of high imagery words.

Emotional valence affects the process of learning. Hence, the use of emotional valence words, positive or negative, creates a relatively biased response. As earlier research suggests, “learning positively or negatively valenced words has a significant influence on diastolic pressure” (Snyder, Harrison, & Shenal, 1998, p. 257). While emotional valence interferes with memory and learning, other factors might also influence cognitive processes. For instance, prioritizing familiar concepts such as terms used more frequently in the quotidian routine of the individual could cause involuntary preference for the neutral words. Conceivably, the neutral pair words used in the study resembled daily activities, which made the positive and negative pair words less likely to be recalled. According to Hannon, Lozano, Frias, Picallo-Hernandez, and Fuhrman (2010), “it is assumed that the importance of the associations is reflected in the strength of the associations” (p. 1225). Therefore, the recall of high imagery neutral words was prevalent, suggesting that meaning and familiarity bind to create a sort of a scale in relation to the importance of the word.

Stress and anxiety are factors related to the creation of false memories. Roberts (2002) reports: “in vivid imagers stress had quite a powerful effect on false memory creation” (p. 249). All of the data gathered for the present study was collected from college students during the fall semester. Some of participants might have been experiencing stress as a result of their scholastic and personal responsibilities. However, stress and anxiety counteract learning by influencing the creation of false memories. Roberts (2002) also explains that, “since state anxiety, via increased arousal, is likely to

interfere with short-term memory effectiveness [citation omitted] then it is also likely to have some impact on the qualities of memories” (p. 249). Therefore, stress not only interferes with learning but also decreases the efficiency of short-term memory.

In conclusion, partial support was found for the hypothesis. The neutral words were recalled more often than the emotional words. It is assumed that the neutral word pairs had higher imagery than the emotional valence word pairs. In addition, higher imagery is considered to require a higher level of involvement as well as additional cognitive processes. Higher imagery words also demand cognitive processes to complement one another, which makes the learning of neutral words more complex. Additionally, prioritizing and unconsciously selecting the information based on the level of familiarity and relevance are important factors in the learning process. Moreover, high imagery is related to the importance and meaning given to a term. Stress and anxiety are factors that counteract the process of learning and memory. Future research should focus on a wider variety of neutral words; perhaps comparing the high and low imagery neutral words could provide a better understanding.

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Appendix 1
Informed Consent Form
Paired-Associate Learning

(Note: Participants will keep for their records)

1. Purpose of the Study: The purpose of the class project is to fulfill a requirement for PSY 355.
2. Procedure: Participants will be presented with paired words for a period of 10 seconds. They will be asked to learn the words, so that they can recall them at a later time. The experimenter will then present only one of the paired words for a period of 10 seconds, the participants will be asked to recall the missing word. The participant will write down a short statement about the strategy used to recall the words.
3. Anonymity of Participants and Confidentiality of the Results: All data will be completely anonymous. All results will be confidential.
4. Discomforts and Risks: There is no risk associated with the present study. However, in the case of any discomfort or risk, the participant can withdraw from the experiment at any time.
5. Benefits of the Study: After completing the experiment, participants' information will be sent to their respective professor for extra credit. Results of the study will be presented at the North Carolina Psychological Association.
6. Freedom to Withdraw: Participants will be free to withdraw at any time during the experiment. If so, extra credit will be given or they will be given another opportunity to earn the extra credit.
7. Approval of Research: Dr. Katharine Snyder has approved the present research. If further information is needed, you can contact her or the experimenter directly. Their information is listed below
Dr. Katharine Snyder
ksnyder@methodist.edu
910-630-7535
8. Permission Statement: You have been informed and instructed about the procedures regarding the present study. You are aware that you will not be required to identify yourself in any of the experiment material. You will be able to withdraw from the experiment at any time.
Participant's Name (Please Print): _____
Participant's Signature: _____
Course: _____
Course Professor: _____
Researcher's Signature: _____

Appendix 2

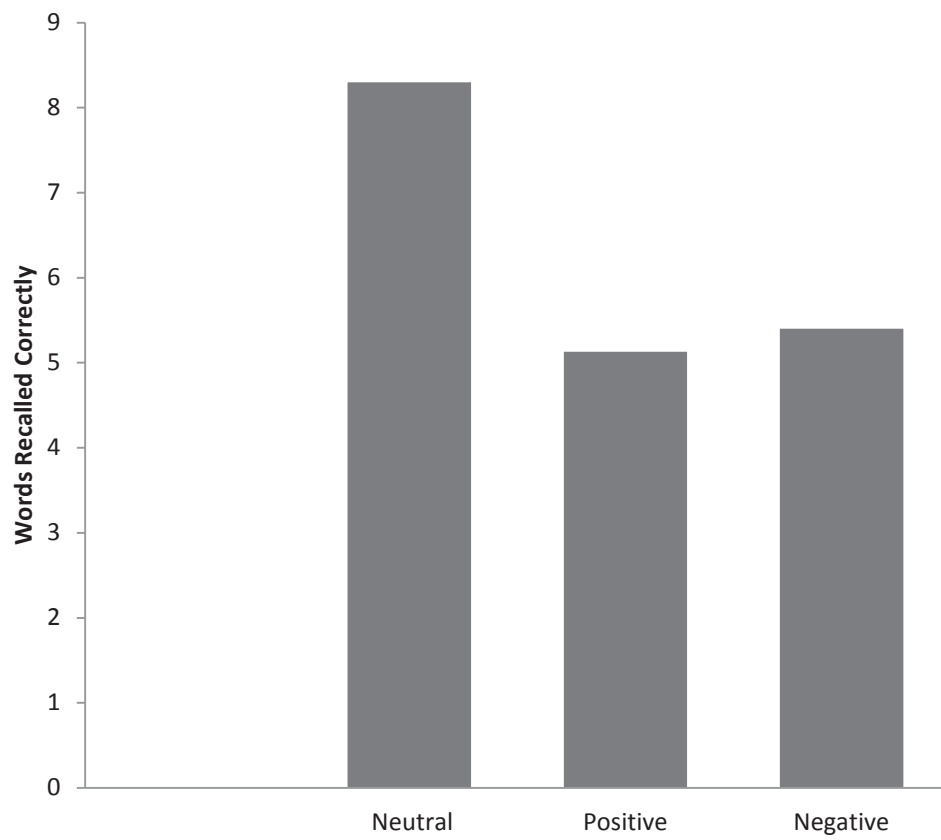


Figure 1. Number of neutral, positive, and negative words recalled correctly in the Learning and Learning Study.