# Emotions and lexical memory

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Is there a link between emotion and memory and, if so, can that link be leveraged in the language learning environment to facilitate the consolidation in memory of lexical semantic items in an L2? L2 subjects were given a list of vocabulary items to learn, including a translation of the vocabulary items. Next they were shown a reading passage which used the vocabulary in context. The participants twice heard an audio recording of the passage while they followed along with the text. Participants were divided into an experimental group, in which the audio recording accentuated the emotional content of the story, and a control group, in which the recording was presented in a neutral tone of voice. A post-test, then delayed post-test, assessed how well the subjects remembered the items.

The hypothesis was that the style of audio reading accompanying the written text (emotional or neutral) would influence the results on a post-test and a delayed post-test on the vocabulary used in the passage. However, the hypothesis was not supported.

Results are discussed in terms of other learning benefits to enhancing the emotional content of the text, which the students in the experimental group found to be more engaging and interesting. Furthermore, methodological issues are examined.

## 1    Introduction

Nearly all intermediate-level foreign language textbooks provide some variation on the theme of a) introducing a set of vocabulary, b) providing a reading that uses the vocabulary in a salient way, and c) reinforcing the vocabulary soon thereafter using exercises and/or activities. In some cases the vocabulary set may be explicitly provided before or after the reading; alternately, vocabulary items may be defined inline (or students may be expected to look up the words). But using a textual medium to help teach and reinforce vocabulary is a pervasive technique.

This paper draws on research in the neuroscience of memory to see if the content of such text can be manipulated in such a way as to increase the students' ability to remember the vocabulary. Specifically, will increasing the emotional impact of a text improve the acquisition of the text's vocabulary?

## 2 Background

Previous findings in the following areas bear on this study in terms of methodology and theoretical designs: Lexical acquisition experiments, studies regarding emotion and memory, and the neurological basis of emotion and memory.

### 2.1 Lexical acquisition experiments

In order to ensure a strong design for this study, contemporary lexical acquisition experiments (e.g. Carter et al, 2001; Min, 2008; Zaid 2009) were examined for their methodological techniques. Rott's (1999) critique of incidental vocabulary acquisition methodologies particularly discussed the importance of the following elements, which were addressed as much as possible in the study design.

A pre-test/post-test design ensured the students did not have previous knowledge of the target vocabulary. A two-way ANOVA looked at differences across the pre-test and post-test as well as the test condition. As a control, one group heard the text read in a neutral tone of voice, the other in a voice that fully engaged the emotional content of the text. In order to be sensitive to "partial knowledge gain," a variation on the Vocabulary Knowledge Index was used to test vocabulary (Wesche and Paribakht, 1996). Finally, students took a delayed post-test (one week after the reading), which tested their retention of the words.

### 2.2 Studies regarding emotion and memory

Is there a link between emotion and memory? This question yields a fairly straightforward "yes" as an answer. In conditioning experiments dating to Pavlov's (1906) famous dogs, a conditioned response (such as the ringing of a bell) can be linked to an unconditioned response (being fed) through repeated exposures. An unconditioned response is something that we inherently desire (such as food, sex, shelter) or that we desire to avoid (such as something that hurts us). Emotions, both positive (happiness, love) and negative (fear), provide the link between the things we want and need and the memory of what we need to do to acquire them.

Applying the principles behind the connection between Pavlov's dogs' food and the ringing of a bell to something as cognitively complex as language requires some deep examination. After all, in Pavlov's case there was a one-to-one connection between the unconditioned and the conditioned response. Furthermore, the experimenter was able to reinforce the connection through repeated exposures. While this technique might apply if we only cared to teach a single word (such as "spaghetti") to a single student who was dependent on us for

food, it clearly does not scale up in any useful way.

Nonetheless, if we examine the neurology behind this learning mechanism, we might be able to leverage what we learn to inform materials that will promote semantic memory in a language learning environment.

## 2.3 The neurological basis of emotion and memory

### 2.3.1 Different memory types, different learning mechanisms

Squire (1986) articulates two main type of memories: Declarative (which includes episodic and semantic memory) and procedural (implicit knowledge such as skills). Furthermore, Squire's examination of results from experiments with amnesiac patients led him to conclude that classic conditioning is "phylogenetically old" (p. 1615) and relies on different neurological mechanisms than declarative memory consolidation, which is more recent from an evolutionary standpoint. Numerous studies (summarized in LaBar, 2009) show that damage to the hippocampus can cause amnesia for declarative memory but not for procedural memory.

### 2.3.2 The memory modulation hypothesis

The story of the connection between emotion and memory starts in the medial temporal lobe, where the amygdala modulates the consolidation of memory. fMRI studies, as well as studies of patients and animals with pathology in these areas, have let us measure the activation in these areas and to make correlations between their activation and the consolidation of memory.

James McGaugh (2004) provides an interesting theory of how the amygdala might serve to link memory and emotion in the human brain. According to McGaugh, there is a mechanism whereby "neuromodulatory influences occurring selectively within the baso-lateral amygdala (BLA) regulate the consolidation of memory for various kinds of experiences through BLA projections to many other brain regions involved in storing newly acquired information." (p. 2) Apparently the chemicals produced in emotional response activate the processes which consolidate memory.

Experimental support for the effect of the amygdala in fear conditioning is detailed in McGaugh (2004). Rats, for example, who are given fear conditioned training and then subjected to electrical stimulation of the amygdala have their memory of the training impaired. Expanding this theory to humans and to other types of emotional responses, McGaugh analyzed studies which suggested that hormones secreted by arousal readily enter the brain, where their effects are mediated by the BLA.

## 3    Hypotheses

Given this link between emotion and memory, the hypothesis under investigation is that semantic memory will be stronger, as measured by performance on post- and delayed post-tests, when the lexical item was learned in the context of a story read in an emotionally engaging tone of voice in contrast to the same story read in an emotionally neutral tone of voice.

Importantly, the lexical items used in this study (such as "leather," "leave of absence," "to backfire") do not have any particular emotional content. The idea is that the emotional impact of the story itself will trigger memory.

## 4    Methods

### 4.1    Methodology

The experiment was run over the Internet with the participants using their own equipment. An Adobe Flash program controlled the sequence and sometimes the pacing of the steps; subjects could not "jump around" or skip sections. First, a pre-test checked the subject's knowledge of the target vocabulary. Next the subjects were shown a set of vocabulary words, with the translations in English.

Next, subjects listened to and read along with a short passage in the target L2 (French) which used the vocabulary words in a semantically salient way. The reading style was manipulated, with subjects either hearing a reading which accentuated the emotionally engaging elements of the passage, or a neutral reading of the same passage in a flat tone of voice. A post-test was given after the reading, as well as a few comprehension questions and some subjective questions to find out if they found the passage to be emotionally interesting. Finally, a delayed post-test was given one week after the session.

### 4.2    Participants

Participants were L2 (French) learners. There were 15 subjects in the study but only 12 in the analysis because 3 subjects neglected to complete the delayed post-test. Because understanding the non-target words in the reading passage was critical to the evaluation of the results, participants were in a third semester language class. All students had a good knowledge of English (for purposes of initial presentation of the lexical items and their translations); their linguistic background was collected along with age and gender.

Participants were recruited primarily from an Intermediate level French class at a Canadian (British Columbian) university.

### 4.3    Stimuli

There were 16 target lexical items -- enough to well exceed the span of immediate memory but few enough that they could all be contained in a passage that would be read in a single setting.

The lexical items were scored via a "Vocabulary Knowledge Scale" which indicated the degree of familiarity with the lexical item. The scale ranged from 0 (completely unfamiliar) to 3 (the student knows the meaning and can use it correctly in a sentence).

### 4.4    Procedure

This study was conducted via an Adobe Flash movie created by the experimenter. The movie sent all user input to a program on the experimenter's server. This program saved all user input to a tab-delimited text file, the contents of which were later transferred to SPSS. Input collected included informed consent, background info, such as the participant's age and L1, the date/time that the participant completed each screen, their answers for the pre-test and post-tests, and the answers for the comprehension/subjective reading assessment questions.

Participants who completed the study were rewarded $5, either cash or with a digitally-redeemable reward, such as an Amazon.com gift certificate.

### 5    Analysis

Vocabulary scores for each "familiarity" rating were manually adjusted by the researcher. If the subject indicated they knew the meaning of a word and gave a correct definition they were scored a 2; if however their definition was incorrect their score was reduced to a 1 ("I've seen this word but I don't know what it means."). Originally sentences which correctly used the word were scored as a 3. However, it was noted that some participants were simply more diligent than others in producing sentences. That is, some subjects wrote many sentences in their tests, others wrote none at all, although they seemed to have a command of the meanings. Since the purpose of the study was to measure vocabulary gain, and not diligence, all scores of 3 were reduced to 2.

The main analysis was a repeated measures analysis of variance. Also analyzed was the correlation between the test condition (hearing an emotional vs. neutral reading) and the subjects' subjective impressions (whether they found the story emotionally engaging and whether they were interested to learn what happens to the characters).

## 6    Results

The hypothesis was that the style of audio reading accompanying the written text (emotional or neutral) would influence the results on a post-test and a delayed post-test. However, the hypothesis was not supported ($p = .273$), as shown in Figure 1.
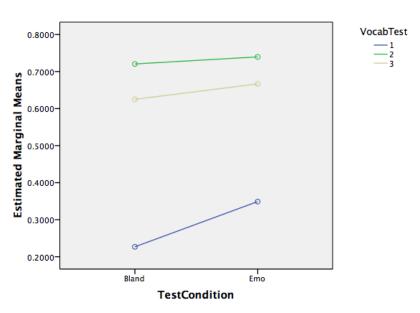


**Estimated Marginal Means of MEASURE_1**

*Figure 1.* Plots of Vocabulary Test Mean Scores (1=Pre-test, 2=Post-test, 3=Delayed Post-test)

Tempting though it might be to dismiss the results as being due to the audio recording not necessarily invoking an emotional response, the subjective reporting of the subjects showed a correlation ($p = .022$) between the test condition and the response to the question, "Did you find the story to be emotionally engaging?" There was also a strong correlation ($p = .002$) between the test condition and the response to the question, "Are you interested in finding out what happens between Joyce and Jean-Pierre?"

## 7    Discussion

There may indeed be a neurochemical relationship between emotion and memory, but such an effect was not shown here to improve the acquisition of L2 vocabulary. Although it's frequently disappointing when one's hypothesis is not supported, given the complexity of how memory works as well as the second language acquisition process, it is perhaps not surprising in this case.

Most of the lessons learned from this study had less to do with the hypothesis than issues with experimental design, so the following sections focus on some insights here.

### 7.1    The Vocabulary List

In hindsight, the lexical items which were used to score the study should have been more thoroughly vetted. Some of the words were remembered at a very high rate. Two of these were false friends ("*massifs*" and "*derange*"). These words led to many incorrect guesses and possibly skewed scores on the pre-test.

### 7.2    SLA and Motivation

It was encouraging that the "emotional" reading condition significantly correlated with a higher level of interest in what was going to happen next in the story. Although this was not in turn correlated with a higher level of vocabulary acquisition, a foreign language teacher might find such interest quite significant. Curiosity and interest might lead students to be motivated to read more stories from the same source, which would likely improve their language learning overall. This is an entirely different direction of research that might be fruitful to pursue.

## 8    Conclusion

The chemical response to emotion that the amygdala has on the activation of semantic memory may be not only too subtle to measure, but indeed too subtle to be worth trying to influence. It may be better to move a little further up the cognitive science chain, looking at memory effects that happen at a higher level, perhaps from a more psycholinguistic point of view.

Nonetheless there are certainly other and good reasons to continue to strive to build language learning materials which engage the mind and touch the spirit. Long before MRI's, before Pavlov, before even the written word was conceived, people have used the story form as a mnemonic device to convey cultural, historical, and moral information. It has its own structure, its own language. As Egan (n.d.) says, "The story insures memorization by investing the material to be

learned with the qualities that engage the imagination in the process of learning."

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