

The Effect of Negative Emotion on Memory Recall:  
An Online Comparison of Fear, Sadness, and Disgust  
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### Abstract

Previous studies which have involved emotion and memory recall have primarily focused on the effects of sadness and pleasant mood on recall ability. In the present study, the effect of negative emotions on memory recall ability was examined. 71 participants were randomly assigned into four conditions: fear, disgust, sadness, and a neutral control group. All participants were shown the same video which displayed 20 words individually for 3 seconds. Participants then viewed a video chosen specifically for their condition which was intended to elicit the emotion assigned to their condition group. Following the condition-specific video participants rated the emotions they experienced during the preceding video using the SPANE scale. Upon completion of this scale, participants were asked to recall as many words as they could remember from the first video. The number of words participants freely recalled in each group were compared. The results showed minimal differences between condition groups and the findings were not significant.

*Keywords:* emotion, memory, free recall, fear, sadness, disgust

### The Effect of Negative Emotion on Memory Recall

Emotional experiences are often remembered with greater ease and in more detail than experiences that do not illicit an emotional response (D'Argembeau & Van, 2005; Reisberg & Hertel, 2003). In contrast, it has been demonstrated that despite the ability of emotional experiences to create strong memories, when encoding (the process of taking information into the brain for storage and later retrieval) takes place in an emotional state outside of an emotional event (e.g. feeling an emotion without apparent cause or an emotional state provoked during research), memory recall capabilities decrease (Knott, Threadgold, & Howe, 2014). Memory and emotion have been examined in a variety of ways and the results often seem contradictory to one another. We will briefly discuss four ways that the effects of emotion on memory have been investigated and why these different methods are important to consider for future research on memory. Each study has directly benefited the field of emotional memory research and the summarized experiments that follow will serve as the basis for a new new memory experiment designed to close an important gap. Although negative and positive emotions have been extensively researched, to our knowledge, no study has directly compared the effects of the various negative emotions on working memory, namely, sadness, fear, and disgust.

Many factors contribute to memory encoding and accurate recall, particularly emotional states at the time of encoding. For example, studies have found that a depressive state both during and after encoding decreases the ability to accurately recall memories. A study conducted by Ellis, Thomas, McFarland, and Lane (1985) examined recall abilities when a depressive or neutral emotional state was induced after the participants read sentences embedded with target words. Participants were assigned to either depressive or neutral mood groups in combination

with reading simple or elaborate sentences. The subjects read 10 sentences according to their assigned group and rated the sentences based on their comprehensibility. Following this task, the subjects began the mood inducing procedures in which subjects read 30 negative or 30 neutral statements. After the mood inducing procedure, subjects were given an unexpected cued recall test in which they were shown the same sentences as before, however, the target word was absent and subjects were asked to recall the missing word. The results from this test showed memory recall abilities were significantly reduced in the depressive condition.

A decrease in recall ability following a depressive state was also demonstrated in a study conducted by Knott et al. (2014). In this study, researchers induced a desired mood in participants by having them watch a 5 minute clip intended to elicit a depressive or positive mood. The control group did not watch a film and began the experiment in their existing mood state. Participants reported mood ratings before and after watching the film clip. Shortly after participants reported their mood ratings, words from a DRM list (a list of affiliated words associated with a non-presented target word that participants often falsely remember) was read aloud to the participants. After listening to the DRM list each participant completed a distractor task that was followed by an unexpected recall test for the words that were on the list. Four of the critical lure items served as primes for completing the Mednick's Compound Remote Associate Task (CRAT) – a task in which participants are presented with three words that share a common solution word (e.g. the words *basket*, *foot*, and *base* would have the solution word *ball*). Participants completed eight CRATs, four of which contained the non-presented critical word from the DRM list. A subsequent recall test was given of the primed words and the unprimed words from the CRAT.

Similar to the findings of the Ellis et al. (1985) study, participants in the negative mood group had a lower recall rates than participants in the positive or control mood groups (Knott et al., 2014). In fact, the negative mood group had the same recall rate for the primed word condition as the positive and control mood group had for the unprimed words. Thus, priming words for the negative mood group had little benefit as priming the words did not increase their recall rate. This is an indication that mood has an effect on recall capabilities.

Despite the preceding evidence that negative emotional states decrease memory recall, there are substantial findings that negative emotional stimuli and events create more vivid and easily accessible memories. This finding complicates the relationship between emotion and memory. In a study that examined the effects of emotion on memory as it relates to temporal information retrieval, D'Argembeau and Van (2005) had participants view emotional pictures (positive, negative, or neutral), and later tested them on the order and location of the pictures. Their results suggested that emotional valence does indeed affect temporal memory, with recognition better for emotionally charged pictures than neutral, and better for negatively charged pictures in relation to positive pictures. Prior research that investigated emotion and memory has mostly been to determine the effect, if any, of negative, positive, or neutrally valenced stimuli on general memory capabilities, not the ability to accurately recall location and time details about the presented stimuli. This area is of interest due to the implications of temporal memory on evolutionary survival instincts, which play an instrumental role in the effect of negative emotions on memory (Knott, Threadgold, & Howe, 2014). Negative emotions may have served as a strong survival instinct (fear helps to avoid danger, sadness brings support from others, and disgust would serve as a moral compass and a form of protection from the ingestion

of harmful substances.). These negative emotions would have been reinforced over time, creating strong bonds in memory and survival instincts. Temporal memory regarding the location of emotional stimuli would have been a necessary element of survival.

Knott et al. (2014) tested participants separately by use of a between-subjects design, and provided each subject with 3 study lists from a list-discrimination paradigm. Each list contained 7 positive, 7 negative, and 7 neutral images. Subjects were asked to learn each picture and informed that they would be tested on them later, but the necessity to retain the order of pictures (temporal information) was withheld. Pictures were presented on a computer screen and during the 3 minute delay between list presentations participants were asked to complete some basic math problems. After the third and final list, subjects completed math problems for 1 minute and were then given a memory test. Participants were asked to recognize the pictures they had viewed among new ones by pressing 1 for a previously displayed picture or 2 for a novel picture. Then, if they recognized the picture, they were asked to press 1, 2, or 3, to indicate the list (first, second, or third) in which the picture had occurred. At the end of the memory test all participants were questioned on whether or not they suspected they would be tested on their memory for which list each stimuli was displayed. Every participant answered no to this question.

Their results revealed a main effect of picture type, and further testing showed that item memory was better for both negative and positive pictures than for neutral ones (Knott et al., 2014). It was also found that negative pictures had a stronger effect on memory than positive and neutral pictures, and women exhibited better item memory in general than men in a gender analysis. These results support the idea that negative emotions creates the strongest memories (D'Argembeau & Van, 2005; Reisberg & Hertel, 2003). Results of this study also supported the

claim that negative emotion increases temporal memory retrieval. The ability to easily recall a memory from the past that has strong emotional links is common for most people, whether it be a holiday or the birth of a child, but memories that elicit negative emotion seem to be the strongest. We remember hard times, moments of sadness, despair, grief, and loss with intensity and vividness. This study represented a starting point to determine if memory strength for temporal information is affected by the different major negative emotions.

In another study on emotion and memory, Curci, Lanciano, Soletti, and Rime (2013) found that after highly emotional events a process called rumination begins. Rumination can be defined as focused, often obsessive and compulsive thoughts that replay negative emotional states or experiences through a person's mind. Curci et al. believed that these ruminative thoughts may deplete working memory capacities normally allocated to other tasks. This disruption in working memory due to ruminative thoughts are believed to continue over time, thus these interruptions may have lifelong negative effects. It was hypothesized that participants with lower working memory capacity would score worse on an operation-word memory span test (OSPAN) than participants who tested higher in working memory capacity. According to Lavie's Load Theory of Attention, participants in the low working memory capacity group should have very little mental capacity left over to attend to outside stimuli once the ruminative processes begin. Those in the high working memory capacity should be less affected by the rumination that may ensue after an emotional event, compared to the low load group.

The OSPAN test consists of strings of simple math equations (like  $2 \times 4 + 1 = 9$ ,  $7 - 5 + 3 = 7$ , etc.) in which some equations were correct and some were wrong, followed immediately by a two syllable word (i.e., *table*.) While participants indicated whether the equation was right or

wrong by pressing a specific key they were required to say aloud the word that was presented after the equation. Participants were scored on the number of correct responses to the math equations as well as how many words were remembered from each set of number and word presentation grouping. Curci et al. (2013) hypothesized that subjects within the low working memory group would have longer-lasting, negative thoughts in the 24 hours following the experiment and would report the highest rate of rumination of all the groups. This hypothesis is based on the idea that individuals who suffer from high rates of rumination often experience difficulties in daily life and cognitive processing due to excessive mental energy spent in negative thought. By applying Lavie's Load Theory, it seems as though the opposite would also be true, and those subjects with low working memory will have more mental energy left over to spend on negative thoughts, compared to those with high working memory who use the majority of their mental energy for task-relevant stimuli.

To assess working memory function and strength, researchers administered a preliminary test called a Random Number Generator (RNG) test (Curci et al., 2013). This test uses a string of 50 random numbers (from 0 to 9) that participants must repeat aloud at the rate of one per second. Scores are measured by the sum of the squared length of each incorrect sequence of at least two numbers. The higher the score on the RNG test, the lower the subject's working memory capacity). After scores were calculated, only those 50 participants who were below the first quartile and the 50 who scored above the third quartile were invited to continue in the study, thus creating the two levels of working memory capacity; low and high.

Participants were tested on emotional state and a test of ruminative tendency immediately upon lab arrival. Subjects were then given an OSPAN test and asked to read the first excerpt,



which was either negative or neutral. Participants completed the OSPAN test again and were then asked to write a small summary of what they read. Subjects then rated each reading on emotional intensity, and were retested on emotional state and rumination a final time. Curci et al. (2013) hypothesized that subjects within the low working memory group would have longer-lasting, negative thoughts in the 24 hours following the experiment and would report the highest rate of rumination of all the groups. Lastly, participants were asked to complete a questionnaire via email precisely 24 hours after lab tests occurred, which checked for rumination and emotional state levels.

Results showed a main effect of both emotional valence and working memory capacity. As hypothesized, individuals in the high working memory group were better able to attend to tasks after an emotional event compared to the low working memory group. Further, the difference in before and after OSPAN scores was higher in the low working memory capacity group than in the high level group, which indicated that executive function is affected by emotional experiences more in individuals with low working memory capacity. The large difference in scores before and after the emotional event indicates that working memory is more disrupted by emotional events that cause rumination in individuals with low working memory. In addition, the highest levels of rumination at 24 hours post-experiment were also reported by the low working memory group of participants.

Curci et al. (2013) examined the impact of negative emotion on executive function in individuals with different working memory capacities. In one of the first attempts to distinguish between low and high working memory within the field of emotion, Curci et al. displayed measurable differences in rumination and working memory capacity among the two groups.

These findings created space for future research within the field of emotional regulation and the effects of different emotions on memory as it relates to working memory load capacity. This ability to control for working memory capacity enabled researchers to thoroughly explore the link between memory and rumination in a new way. This is an important area to consider in our current study, which will examine the different effect levels of three negative emotions on memory.

In summary, previous studies have examined the effect of emotion on working memory (Curci et al., 2013), as well as how different valenced emotions may affect temporal memory retrieval (D'Argembeau and Van, 2005). In the study conducted by Curci et al. (2013), negative emotion was reported to affect participants in the low working memory group for longer, and with more negative effects reported than in the high working memory group. In the study by D'Argembeau and Van (2005) subjects showed greater temporal memory retrieval after reading negatively valenced passages in comparison to neutral excerpts. In contradictory studies by Ellis et al. (1985), and Knott et al., (2014), negative emotion was shown to decrease memory function when tests were done in a depressive state and when emotions did not accompany an emotional event, respectively. Since no prior study has examined the effect of different negative emotions on memory recall, the current study aims to explore this topic.

The goal of the current study is to fill the gap in existing literature that does not differentiate between different negative emotions in relation to memory function. We will examine the effect of sadness, disgust, and fear, and how these different negative emotions affect memory capacity. It has been shown that negative emotions have the strongest effect on working memory processes (D'Argembeau et al., 2005; Curci et al., 2013) in comparison to neutral or

positive emotions. There is also literature that reports negative emotions create the strongest and most accurate memories (Knott et al. 2014; Ellis et al. 1985). We hypothesized that fear will have the greatest negative effect on memory recall, due to numerous biological events that occur when fear is elicited. For one, the release of excess cortisol has been shown to hinder hippocampal function, which is directly implicated in the formation, storage, and retrieval of new memories (Carlson, 2011). In addition, fear is an important aspect of species survival and a strong reaction is automatically elicited when faced with a fearful stimulus. Next, we believe disgust will have the second greatest negative effect on working memory, due to the link between disgust and survival. Over the course of evolution, disgust is believed to have evolved to protect man from the danger or poisonous or harmful ingestion. When we encounter a stimulus that elicits disgust, we would remember this stimulus, in order to avoid future encounters or the possibility of illness. Lastly, we hypothesize that sadness will have the least effect on working memory due to literature written by Storbeck and Clore (2005), which details the effects of sadness and happiness on memory functions. Storbeck and Clore reported that sadness increased memory accuracy.

## **Method**

### **Participants**

The present experiment was posted to the author's Facebook accounts, and links for the opportunity to participate were provided, along with an open invitation for anyone to participate. The purpose of the experiment was withheld, and possible participants were informed that the experiment was to fulfill graduation requirements for Eastern Oregon University. No identifying information was collected, and of the 75 participants that followed the link to SurveyMonkey, 71

completed the experiment. Prior to beginning the experiment, all participants gave informed consent to participate and were told that they were free to withdraw from the experiment at any time.

## **Materials**

The experiment was administered through the SurveyMonkey website. Participants completed the experiment on their own time where a computer was available.

## **Procedure and Design**

In this between-subjects design, participants were informed that some of the faculty members of Eastern Oregon University might offer extra-credit for participating. Participants were shown a soft-blue screen that informed them of experiment length and were asked to set aside 15 – 20 minutes before beginning the experiment in a quiet, distraction-free environment. Participants were randomly assigned to one of four conditions: fear, sadness, disgust, or neutral. After condition assignment, participants were given access to the experiment and redirected to the Survey Monkey website. Information regarding the specific hypotheses of the experiment was not provided.

To begin, all participants were shown the same 20 neutral words (*e.g.* , *table*, *fruit*, *plane*). Each word was displayed individually for 3 seconds. Participants were not instructed to memorize the words and there was no indication that the presented words would be used at a later time in the experiment. After viewing the words, participants were shown a video specific to their assigned condition. All participants were asked to turn up their computer's volume to a comfortable level before beginning the video. Participants in the fear condition were shown a two minute video in which they were asked to search for a specific object on the screen. After 1

minute and 47 seconds, the image of a screaming figure popped up on the screen, with the intent to elicit fear in the participant. Participants in the sadness condition were shown a two minute video of a starving children in Africa. This was shown with the intent to elicit sadness in the participant. Participants in the disgust condition were shown a two minute clip of people vomiting, meant to elicit disgust.

After watching the assigned videos, all participants were asked to complete an unexpected free recall test of the list of words shown at the beginning of the experiment. Performance on this free recall test served as the dependent variable. After completion of the free recall test, participants were given a simple emotion test based on the SPANE scale (see *Table 1*). Eight emotions were listed separately on the screen and participants were asked to rate each on a ten point scale (1 being no emotion felt and 10 being strong emotion felt), to rate the emotion they felt while watching the video. After providing an emotion rating participants were debriefed on the purpose of the experiment.

## Results

As hypothesized, participants who were assigned to the fear condition recalled fewer words than those in other conditions ( $M = 4.41$ ). This was followed by disgust ( $M = 5.81$ ), sadness ( $M = 6.06$ ), and neutral ( $M = 6.2$ ). A one way ANOVA was performed to analyze the data. Despite participants in the fear condition recalling fewer words than those in the sadness, disgust, and neutral groups, these results were not significant  $F(3,67) = .91, p = .442$ . *Figure 1* demonstrates these findings (see Appendix). The emotions experienced by the participants during the condition video were assessed using the SPANE scale. Results indicated that participants in the sadness condition experienced the greatest overall negative emotion (Average

score 28.39 out of 35), followed by disgust (score of 19.72 out of 35), fear (score of 19 out of 35), and lastly the neutral condition (9.93 out of 35). Complete results from the SPANE assessment are shown in *Table 1*.

## Discussion

We hypothesized that fear would cause the greatest disruption in memory followed by disgust, sadness, and the neutral emotion group. Although it was not statistically significant, participants in the fear condition remembered numerically fewer words than participants in the other conditions. Also, fear and disgust were the only condition groups in which one or more participants reported they could not remember any words; fear ( $N = 2$ ), disgust ( $N = 1$ ). We believe that the participants reported fewer words in the fear condition because the surprising image disrupted concentration and attention.

The present study revealed that different negative emotions may not have a significantly different effect on memory recall, when presented in a strictly online forum. Previous studies such as that of Knott et al. (2014) have found significant results that support sadness as the strongest emotion to negatively affect memory recall abilities. Other studies have yet to include fear and disgust in their tests in addition to sadness. The methodology used in the Knott et al. (2014) study for inducing emotions was similar to the methods we used; a video was selected for each condition according to emotional content. However, their video was two minutes longer than the videos shown during our study. The shorter length of our videos may have had less of an effect on the strength of the emotions induced in participants.

Aside from the possibility that our videos did not have strong enough emotional content, our study had several other limitations. Most importantly, participants completed the study in a non-controlled environment. Ideal conditions would be in a laboratory setting where participants could be monitored and the environment would be distraction-free and quiet. Due to the experiment being completed at the participant's convenience and in any location, it is unknown if every participant completed the experiment in the type of environment that the researchers requested. It was also requested that participants complete the experiment on a desktop or laptop computer instead of completing the experiment via cell phone or tablet, this was because we believe the larger screen and better sound quality would have a more profound effect on the participant's emotional state – particularly in the fear condition in which a figure “popped” up onto the screen. Because it was not surveyed, it is unknown which method the participants used for the experiment.

Of our experiment limitations, recruitment of participants was not one of them. Participants were recruited through Facebook and of the 75 participants we collected data from, only four were excluded from the final analysis. Exclusion from the study was due to incomplete submissions. Although our study was unable to provide significant results in relation to different negative emotions on memory recall abilities, it did provide some insight into memory disruption in regards to various negative emotions, as the fear condition resulted in less words remembered than any other condition. Recommendations for future research on the effects of different negative emotions on memory recall include more powerful manipulations and a controlled environment. In addition, attempts to elicit strong negative emotions using online forums may not be sufficient to obtain significant results in emotional memory research.

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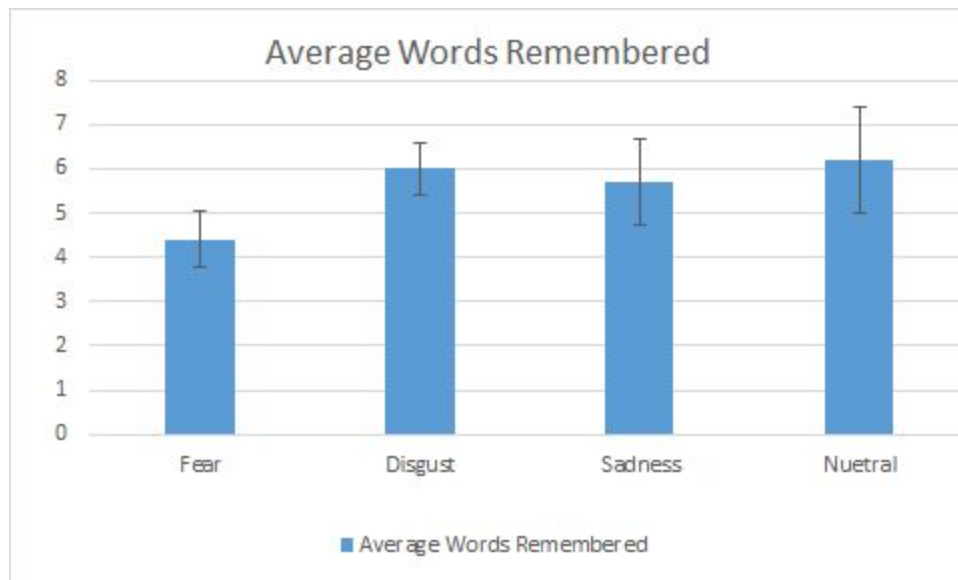
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*Table 1*

Condition ▼	Average + Score ▼	Average - Score ▼	Mean # of words remembered ▼
<b>Fear</b>	16.12	19	4.41
<b>Disgust</b>	11.33	19.72	5.81
<b>Sadness</b>	6.5	28.39	6.06
<b>Neutral</b>	20.47	9.93	6.2

*Table 1.* Mean scores of positive and negative valence after viewing videos eliciting fear, disgust, sadness, and neutral emotions. Scale is from 5-25 (25 is the most positive) on positive ratings, and 7-35 (35 being the most negative) on negative ratings.

*Figure 1**Figure 1.* The average number of words remembered for each of the four conditions.

## Appendix

*Neutral Word List*

Table

Salad

Dog

Chair

Sock

Bench

Phone

Glasses

Rock

Tree

Card

Purse

Television

Sun

River

Egg

Bird

Apple

Bathtub

*Scale of Positive and Negative Experience (SPANE)*

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Please think about the video that you viewed during this experiment. Then report how much you experienced each of the following feelings, using the scale below. For each item, select a number from 1 to 5, and indicate that number on your response sheet.

1. Very Rarely or Never
2. Rarely
3. Sometimes
4. Often
5. Very Often or Always

Positive

Negative

Good

Bad

Pleasant

Unpleasant

Happy

Sad

Afraid

Joyful

Angry

Disgusted

Scoring: The measure can be used to derive an overall affect balance score, but can also be divided into positive and negative feelings scales.

Positive Feelings (SPANE-P): Add the scores, varying from 1 to 5, for the five items: positive, good, pleasant, happy, and joyful. The score can vary from 5 (lowest possible) to 25 (highest positive feelings score).

Negative Feelings (SPANE-N): Add the scores, varying from 1 to 5, for the seven items: negative, bad, unpleasant, sad, afraid, angry, and disgusted. The score can vary from 7 (lowest possible) to 35 (highest negative feelings score).

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