Selectively Distracted: Divided Attention and Memory for Important Information - A replication and extension study

Aaron Shalf, Amanda Felty, Chelsea Leung, Matthew Su, Tarunika Kapoor, Tatiana Nikolaeva

Undergraduate Student Mentor: Miti Parikh

Graduate Student Mentor: Celia Ford

Cognitive Science and Psychology Undergraduate Laboratory at Berkeley

University of California, Berkeley

Abstract

Distractions and multitasking are generally detrimental to learning and memory. Nevertheless, people often study while listening to music, sitting in noisy coffee shops, or intermittently checking their e-mail. The experiment we replicated examined how distractions and divided attention influence one's ability to selectively remember valuable information. Participants studied lists of words that ranged in value from 1 to 10 points while completing a digit-detection task, while listening to music, or without distractions. Most of the figures were successfully replicated using the given dataset and tools like Microsoft Excel and Google Sheets. Since we were able to arrive at the same conclusion as the original author, we believe this experiment is valid and reliable for application to further extension studies. Our extension study examined correlations between gender and recall ability and between age and recall ability. We concluded that there was no significant correlation between these variables, suggesting these factors did not affect the outcome. This extension further supports the author's results, as age and gender were seemingly not confounding variables.

Key Words: Recall, divided attention, selective distraction, multi-tasking, cognition, memory retention, working memory

Introduction

In dichotic listening environments, human working memory can retain information in correlation to reading comprehension to varying degrees (Turner, 1989, pp.127). The cocktail party phenomenon, a phenomenon where a person at a busy cocktail party - or any other busy environment - can suddenly hear a highly personal stimuli - like their name - and tune into a

different conversation involves using one's working memory. (Conway, 2001, pp.331) This phenomenon could be of significance to this study when individuals have to simultaneously move their attention around during a selective attention task. The ability for a participant to recall information after a selective attention task could correlate to the strength of their working memory capacity and furthermore indicate the underlying factors observed in correlations in recall ability.

Auditory distractions have also been shown to cause working memory capacity to weaken or worsen during a task that involves involuntary attention switching (Berti 2003). Our study precisely dives further into implications with recall ability as a result of auditory distraction.

Types of background music also affect recall ability. According to prior research, it is easier to ignore familiar background music than to ignore unfamiliar background music (Kang & Lakshmanan, 2017; Röer, Bell, & Buchner, 2014). However, other research suggests that familiar music actually leads to more distraction because familiar music is typically enjoyed more, consequently activating more neurological processes including limbic and reward-based neural structures (Pereira et al., 2011). The increase in dopaminergic, reward-based neural activity from listening to familiar music may interfere with one's ability to selectively remember valuable information (Cohen et al., 2014). Familiar music may also trigger memories associated with the music and thus inhibit selective memory and cognitive ability even further (Janata, 2009).

The intensity of content also affects one's ability to recall information. There is a correlation between working memory capacity and completing tasks with divided attention (Otani, 2010, pp.343), When an individual is given less content to remember, his or her working

memory capacity is less strained and more information can be retained due to the lower memory load.

Although individuals typically recall self-relevant information better than irrelevant information, studies have shown that there is no discernible difference between memory of relevant and irrelevant information (Turk, 2013, pp.503) To avoid any statements that could potentially be self-relevant in this study, random short words were used for memory recall. We also regulated the length of the distracting stimulus as this was found to be a potential confound affecting one's performance of a visual task (Demeter, 2016).

This experiment focuses on how distractions negatively affected performance in memory based tasks. Prior studies have investigated how divided attention can negatively affect memory consolidation. They conclude that divided attention greatly hinders an individual's ability to encode memories, but did not have a similar effect on memory retrieval. This suggests that people do not have to worry about distractions as much if they are only attempting to recall information (Iidaka, 2000).

Potential physiological explanations for the differences in recall probability include the brain's capacity to recall such information so quickly. Studies have been conducted to investigate brain activity during split attention and divided attention using fMRI. It has been concluded that divided attention requires much more brain activity especially in the medial and lateral frontal regions of the brain, suggesting that needing to divide attention results in more mental errors due to the neurological interference going on inside the brain (Moisala 2015).

In our experiment, both unfamiliar and familiar music conditions are used to distinguish recall ability. One past study has tested the effects that semantic related auditory distractions have on memory performance. It concludes that semantic distractors convey category

information, indicate that related distractors can actually improve memory performance. Overall, it is concluded that it's beneficial to study words with related rather than unrelated auditory distractors (Hanczakowski, 2017, pp. 61).

Additionally, a past study has explored the impact of irrelevant auditory information on remembering task-relevant visual details while subjects were in complete silence, exposed to white noise, or exposed to sounds recorded at a busy cafe. The findings suggest that when episodic retrieval of target images were tested with written cues, recollection was disrupted more by the auditory distraction compared to silence and white noise (Wais, 2011, pp.1090).

Our experiment focuses on how different conditions impair one's recall ability. One test condition is a full versus divided condition. One past study explores the individuals' ability to be able to successfully remember something under divided attention versus full attention conditions during memory retrieval. It was shown that performance was superior for items that had been tested initially under full attention compared to divided attention. Furthermore, dividing attention during memory retrieval impaired source memory. Dividing attention during retrieval increased incorrect source memory responses, providing evidence that distraction during retrieval may increase false recollection (Dudukovic, 2009). These previous mentioned studies all relate to the conclusions made by the replicated experiment.

Little literature was found regarding associations between recall probability and age and recall probability and gender. This motivated us to pursue an extension study to explore any relationship between age and recall probability and gender and recall probability in the replicated study to assess if these variables were significant confounds that might have invalidated the author's conclusions.

Materials and Methods

Participants

The participants were undergraduate students from the University of California, Los Angeles. There were a total of 192 participants (129 females, 62 males, and 1 unreported) whose ages ranged from 18 to 30 (M = 20.50, SD = 1.75). The incentive for these participants was extra credit toward a course requirement if they completed this experiment. This investigation was founded off a set of original data (N = 96) and replication data (N = 96). The sample sizes that were chosen were based off precedent investigations regarding the value effects on memory and selectivity (Castel et al., 2013; Hayes, Kelly, & Smith, 2013; Middlebrooks, McGillivray, et al., 2016; Middlebrooks, Murayama, & Castel, 2016); the sample size used is a typical standard when it comes to value-directed remembering and selectivity effects.

Design

Stimuli. The Collector program (Garcia & Kornell, 2015) was used to prepare and present the experiment. Each participant was exposed to six different lists, each containing 20 words. . The words range from four to seven letters and have an average of 8.81 (SD = 1.57, range = 5.48-12.65) on the log-transformed Hyperspace Analogue to Language (HAL) frequency scale (Balota et al. 2007). In order to compensate for potential item effects (Murayama, Sakaki, Yan, & Smith, 2014), the words were selected randomly from an aggregate word bank of 280 random nouns and verbs without replacement. Each word is randomly assigned a value from 1 to 10 points. Two words are assigned to each point value per list. The lists and the values of the words varied with each participant. For example, one participant may have been given the 4-point word

window in List 2 while another participant could have gotten *window* in List 5 but for only 1 point.

A pilot study ($N = 48$) was completed to determine which songs would be the background music. The participants were exposed to thirty second clips of different songs and were informed of their titles and artists. Each participant had to give rankings of each song based on their personal familiarity and preference. The participants were allowed to replay the song as they created their rankings. The result includes 12 final songs---6 familiar and 6 unfamiliar. There was a general consensus that the songs are well-liked, upbeat, and mood improving. The chosen familiar songs had an average of 126.6 BPM (beats per minute,) ranging from 120-129 BPM. The unfamiliar songs had an average of 124.5BPM ranging from 113-139 BPM. The list of all the songs presented and the final songs chosen are available.

The chosen songs varied with each participant and were assigned randomly to each participant without replacement. The same song can be presented to two different participants in two separate lists. a participant may hear a specific song during List 2 while another participant can hear the same song during List 6.

Procedures

The participants were randomly assigned a condition. The conditions are full-attention, divided-attention, familiar music, and unfamiliar music. Participants were informed that they would be subject to a series of word lists, each containing 20 words. Each word would be assigned a random point value ranging from 1 to 10 points, with 2 words per point value in each list. The participants were instructed to remember as many words as possible and to try to earn the highest score. They were told that their scores would be calculated after their trial and that their final scores are out of 110 possible points. One word is given every 3 seconds.

Participants in the divided-attention condition were informed that they would also be presented a series of digits along with the words. They were instructed to press the spacebar every time they hear a sequence of three odd digits. The randomly generated digits ranged from 1-9 and are presented a rate of 1 per second. There were eight three-odd-digit sequences in each trial. Although there could be instances where there were one or two three-odd digits in a row, the task is designed to never present four three-odd-digits in a row The participants were not informed of this.

Participants in the familiar-music and unfamiliar-music conditions were told that background music would be presented during their trials. They were told that the music would only be playing in the background during the task and that they don't have to give any response to it. Each song is played for sixty seconds. At the end of each trial, the participants were asked if the music was familiar or unfamiliar. All participants exposed to familiar songs indicated that the songs were familiar and all the participants exposed to the unfamiliar songs indicated that the songs were unfamiliar.

Results

Replication of Recall Probability for Lists 1 and 6

Using Microsoft Excel, the original data spreadsheet was filtered according to the different numbered conditions. For each condition (1-4), the average was taken of each item value (1-10) for List 1. These averages were then transferred to a new spreadsheet, and a line graph was formed based on this spreadsheet. Upon examination, this first replication for List 1 was deemed unsuccessful, because the line graph did not match that of the original paper. It was realized that

the item values were graphed in reverse, and this mistake was corrected for the second attempt. Since the second attempt was a successful replication, the entire process was successfully repeated for List 6.

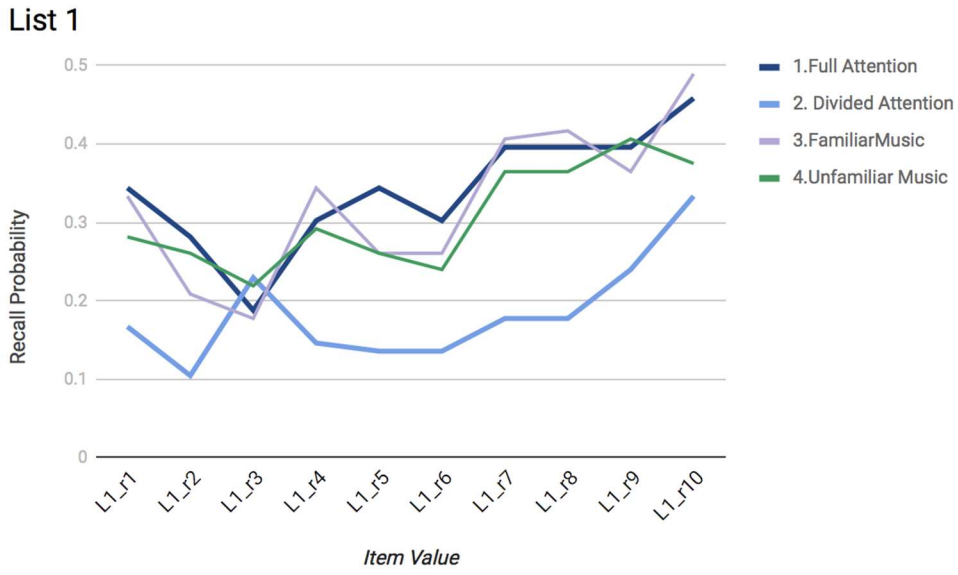


Figure 1. Replication of List 1 Recall Probability. X-axis has intervals for each word in List 1.

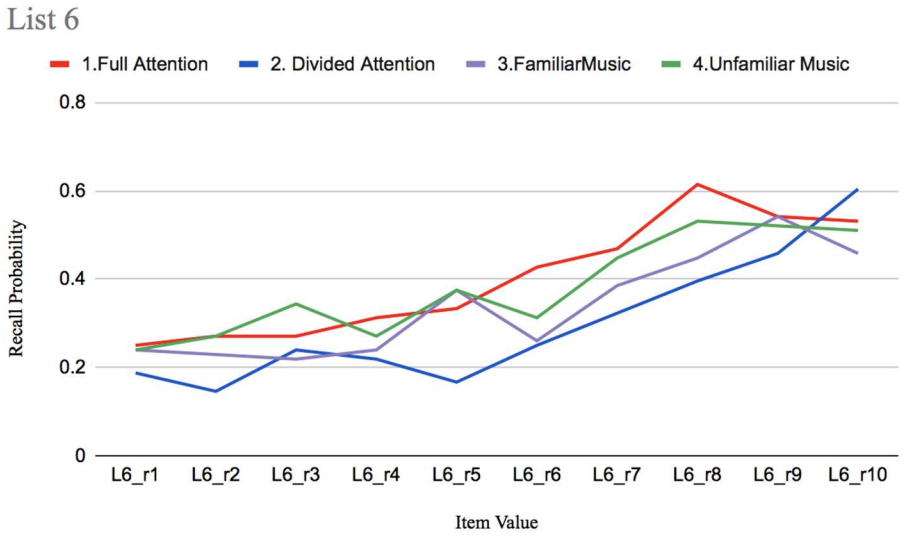


Figure 2. Replication of List 6 Recall Probability. X-axis has intervals for each word in List 6.

Replication of Figure 1

In order to replicate figure 1, the trials were divided into 4 groups based on the values in the "condition" column. Averaging certain columns from each of these respective groups allows us to divide the data into the 4 distinct series shown in the graph.To get the y-values for each point on the graph that represents "Recall Probability," values in columns "avg_r1" through "avg_r10" for each of the conditions were averaged separately. The line graph shown above was created using these 4 groups of averages. This replication was considered successful.

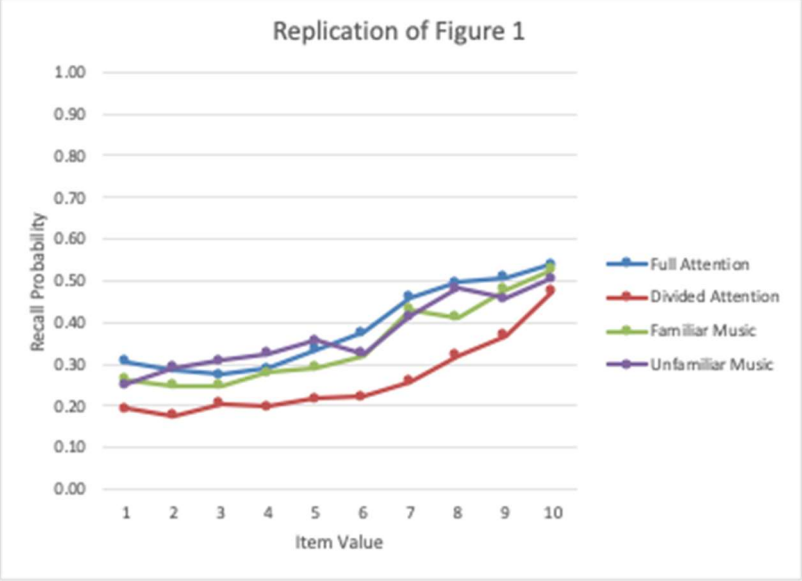


Figure 3. Replication of Figure 1. X-axis has intervals for the item value assigned to words in the lists.

Extension Figures:

The Effect of Gender on Average Recall Rate

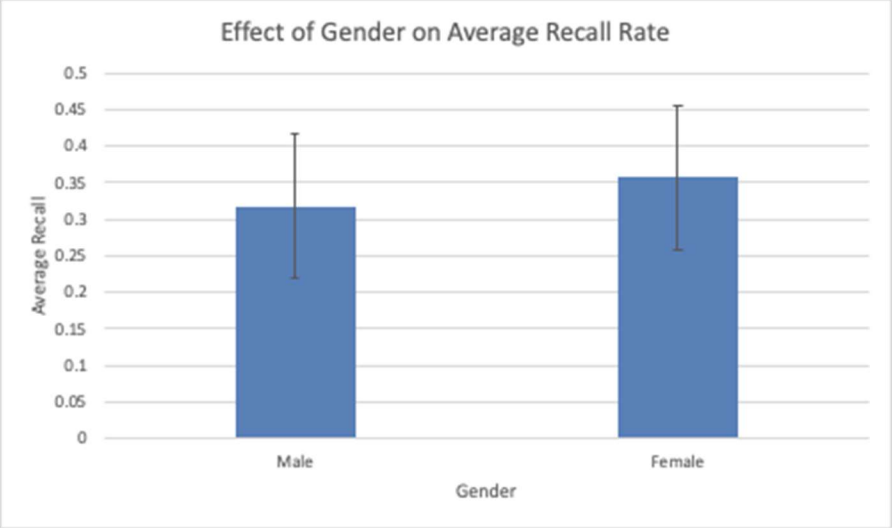
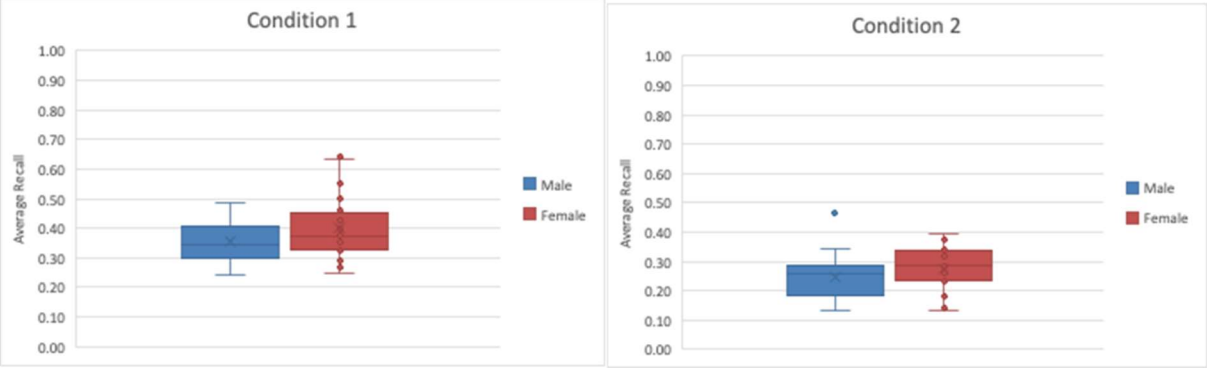


Figure 4. The average recall rates of both males and females when subjected to their respective conditions.



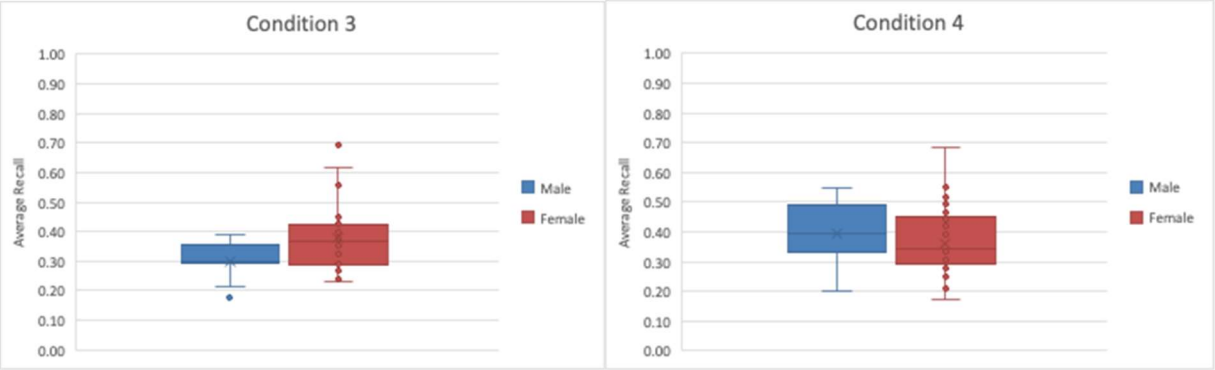


Figure 5. The above plots are box and whisker plots compare the distribution of average recall values for each gender across the different conditions. The data shows that the average recall values for men are generally lower than women; however, this is not consistent enough to be statistically significant. Similarly to Figure 4, our data does not suggest an association between gender and recall probability.

The Effect of Age on Average Recall Rate

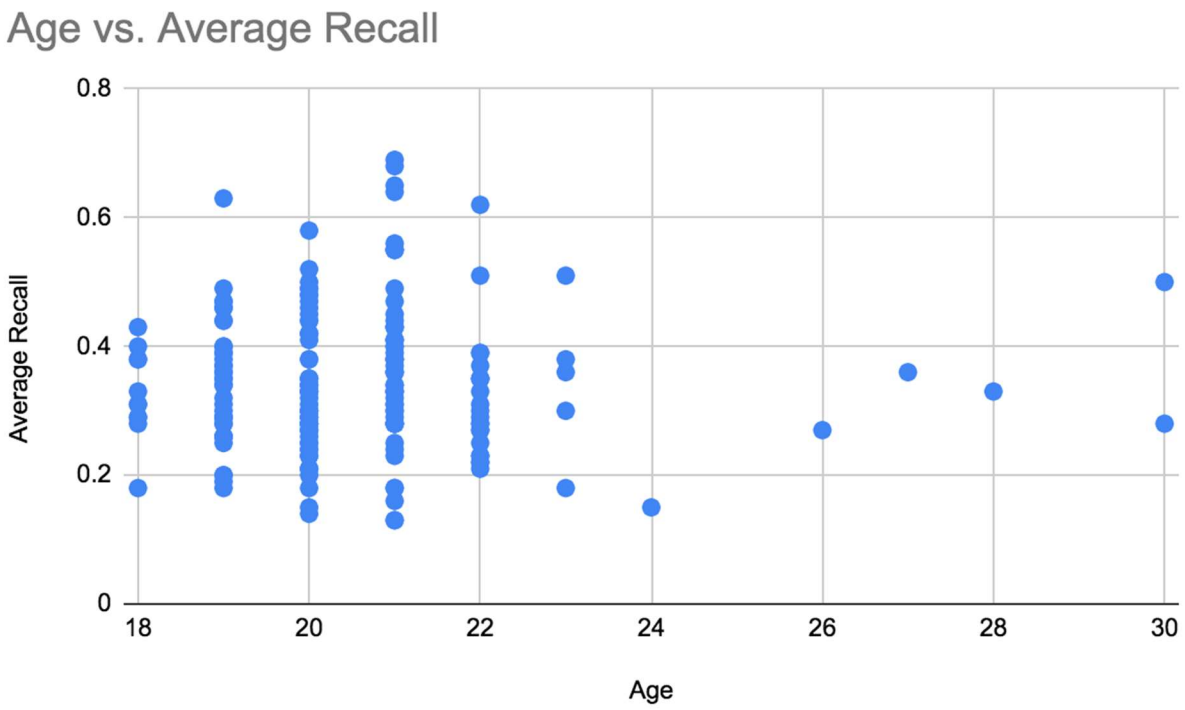


Figure 6. This scatter plot compares age to average recall rates.

Average recall rates are scattered throughout age groups; additionally, most data occurs in the 18-24 age range, leading to greater variability in recall rates among that age group. Overall, however, no specific age had a statistically greater or lower average recall rate than any other specific age. Therefore, it appears that age does not affect average recall rates.

Discussion

The research was centered on the question of whether or not it is possible to divide your attention and still complete cognitive tasks efficiently. Participants are subjected to a variety of distracting stimuli to record their abilities to retain information. The research in this paper contains a variety of practical applications, primarily in learning. The results of our paper show that multitasking does not affect recall probability.

Although the results show that participants performed more poorly on memory tasks while multitasking, their ability to remember words of higher importance was not significantly hindered. This suggests that participants under the divided attention condition were still able to focus on items of higher priority despite a worse general performance.

In our extension study, we were unable to find any correlation between age or gender and performance on memory tasks. Given the little available literature surrounding these variables and recall probability, we are not sure if this conclusion supports the greater literature. However, our results do indicate that it was valid for the original replicated study to not control for these variables when arriving at their results. While this suggests that age and gender does not largely affect working memory, more focused experimentation is required to draw further conclusions.

Our dataset had some drawbacks in regard to those variables, such as the fact that 70% of our participants were a certain gender. If we were to redesign the experiment that focuses on those variables, we'd try to make the selection process more random to get a better distribution of age and gender groups.

The findings of this study could potentially help college students manage their busy lives. Future extension studies should focus on other aspects of life, such as sleep deprivation or education level, to offer more insights on the impact of divided attention. Sleep deprivation is linked with decreased cortical activation relative to activation elicited during rested wakefulness (Chee, 2004). These variables might have a significant impact on recall probability.

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