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ARE OUR MEMORY PREDICTIONS ABSOLUTE OR RELATIVE? THE EFFECT OF COMPARISON ON MEMORY JUDGMENTS

A Master's Thesis

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ABSTRACT

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The effect of divided attention on memory is well documented. However, its effects on memory predictions are not known. One of the aims of the present study was to investigate whether divided attention affects memory performance and prospective memory predictions. The other aim of the current study was to investigate whether people take into consideration the list composition while making memory predictions. In other words, in this study, we investigated whether the effect of divided attention on memory judgments is relative or absolute. In order to investigate these aims, we conducted two experiments. In both experiments, three separate groups were used in the study. One group only studied words under full attention instructions. The other group of participants studied words under divided attention instructions. A third group experienced both divided attention and full attention conditions in a mixed list. Then, these three groups were compared in terms of their actual memory and predicted memory performance. The results revealed no significant difference among these groups in terms of actual memory performance and memory predictions. The results were discussed in terms of findings, limitations and future suggestions.

Keywords: Divided Attention, List Composition, Judgments of Learnings, Metamemory

ÖZET

HAFIZA TAHMİNLERİMİZ MUTLAK MI YOKSA GÖRECELİ MİDİR? KARŞILAŞTIRMANIN HAFIZA TAHMİNLERİMİZ ÜZERİNE ETKİSİ

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Bölünmüş dikkatin bellek üzerindeki etkisini araştıran birçok çalışma vardır. Ancak bölünmüş dikkatin bellek tahminleri üzerindeki etkisi bilinmemektedir. Bu çalışmanın amaçlarından biri bölünmüş dikkatin hem bellek performansı hem de bellek tahminleri üzerindeki etkisini araştırmaktır. Diğer bir amaç ise, bellek tahminleri yaparken insanların liste karışımını dikkate alıp almadıklarını araştırmaktır. Diğer bir deyişle, bu çalışmada, bölünmüş dikkatin bellek tahminleri üzerindeki etkisinin göreceli mi yoksa mutlak mı olduğu araştırılmıştır. Bunu gerçekleştirmek için iki deney yapılmıştır. İki deneyde de üç farklı grup kullanılmıştır. Bir grup kelimeleri sadece tam dikkat yönergeleri ile çalışmıştır. Diğer grup kelimeleri bölünmüş dikkat yönergeleri ile çalışmıştır. Üçüncü grup, kelimeleri hem bölünmüş hem de tam dikkat koşullarını içeren karışık bir liste içinde deneyimlemiştir. Daha sonra bu üç grup hem gerçek bellek performansları hem de bellek tahminleri bakımından kıyaslanmıştır. Sonuçlar, bu gruplar arasında bellek tahminleri ve bellek performansı açısından anlamlı farklılıklar olmadığını göstermiştir. Sonuçlar, bulgular, eksiklikler ve gelecekte yapılabilecek çalışmalar açısından tartışılmıştır.

Anahtar Kelimeler: Bellek Yargıları, Bölünmüş Dikkat, Liste Karışımı, Üstbellek

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CHAPTER I

INTRODUCTION

1.1 Description Of Divided Attention

According to the report of the National Safety Council, 27 % of the total crashes in 2013 were caused by drivers who used cell phones in the car. Especially, with the advance of the technology, cell phones became an important part in our life and we are online 7/24 by using social media accounts, checking our emails, or surfing on the Internet. Although these technological developments make our life easier, they also distract our focus by dividing our attention across multiple domains such as in school, workplace, and even in daily life while focusing on a simple task. This split attention between the computing tasks is defined as divided attention in the literature (Pashler, 1994).

In this study, the effect of divided attention on both memory and memory predictions were investigated. There were two main research questions: First, do divided attention tasks affect people's memory and memory predictions? Second, does list composition play a role in making memory predictions when participants make memory predictions about their subsequent memory performance?

In order to investigate these, first, I will provide information about the effect of divided attention on memory performance. Second, divided attention studies investigating metamemory processes will be mentioned. Finally, the shortcomings of those studies and research questions will be given.

1.2 The Effect of Divided Attention on Memory Processes

In order to investigate the role of divided attention on people's different memory systems, researchers used many methods. One of the most common methods is dichotic listening. In dichotic listening studies, aim is to investigate the influence of selective attention on memory processes (Mulligan, 2008). In these studies, participants are given two different messages simultaneously over two channels via headphones and they are asked to pay attention to one of these channels and ignore the other one. One important study that used dichotic listening paradigm was conducted by Cherry (1953). In this study, Cherry gave participants different messages simultaneously via headphones. The message that participants were requested to attend was human speech. In order to distract participants, experimenters gave different types of sounds, like human speech in English or in foreign language, reversed human speech, music, or just a tone to the other ear. Participants were asked to focus the message in the attended ear and ignore the other channel. Once participants completed the task, they were asked to remember the physical characteristics and the content of the message in the unattended ear to the best of their abilities. The results of the study showed that if the physical characteristics of the both of the messages given to them over the headphone were same, participants failed to ignore the unattended track. However, the study also showed that even if participants failed to shadow the unattended track, they could remember only the physical characteristics of unattended sound but not the content of the sound.

Dichotic listening studies measure auditory selective attention by presenting participants with two separate bits of information from two channels. There are also studies that investigate selective attention through the use of visual materials. In one of these studies, researchers gave participants words surrounded by two digits (i.e. 3 DOG 5; 3 FLOWER 2) (Wolford & Morrison, 1980). In one condition, participants were instructed to not attend to the words but to focus on the digits and to decide whether they were both even or both odd, or different. In the other condition, participants were asked to focus only on the words, not on the digits. After the encoding phase, participants received a recognition test for words. The findings revealed that when participants were asked to attend to the digits, they failed to recognize the words in the memory test, but when they were asked to attend to the words, they showed significantly better memory performance.

The other common way for investigating divided attention effect on memory performance is dual task paradigm. In this method, people are asked to focus on two tasks at the same time and their performances are compared with the single task condition (Neath, Farley, & Surprenant, 2003). For instance, Benjamin et al. (2000, Exp. 1) instructed participants to memorize a word list while they were listening to an audiotape. In the experimental condition, as the main task, they gave participants a picture of a person associated with a sentence about this person and they were asked to memorize these pictures and sentences to recall later. At the same time, they were asked to listen to numbers varying from 1 to 9, delivered over the headphones, and to write down the digits in the target string on a response sheet. In the full attention part, participants just focused on studying the words without the distractor task. Later, researchers compared participants' memory scores from divided attention and full attention conditions and reported that participants performing the main task accompanied by a secondary task recalled fewer words associated with every picture than participants who completed the task without distractors.

Likewise, Gaspelin, Ruthruff, and Pashler (2013) also used dual task paradigm in order to investigate the relationship between divided attention and memory retention. In this study, they requested participants to study a list of words while listening to a sound via headphones. Participants, in the secondary task, were asked to count the number of high-pitched tones (800 Hz) amongst the low-pitched tones (225 Hz). As in the other dual paradigm studies, researchers compared the memory scores of participants in the dual task condition with the single task condition. As in previous studies, the study showed that memory retrieval is influenced by the concurrent task completed during encoding phase.

Studies also used articulatory suppression to look at the relationship between divided attention and memory processes. In this method, in order to distract participants, researchers instruct participants to repeat a verbal item continuously while they are performing a main task (Alloway, Kerr, & Langheinrich, 2010). For instance, in many studies using articulatory suppression as a concurrent task, participants are asked to say "the the the" repeatedly during the whole encoding procedure

(Wickham & Swift, 2006; Franssen, Vandierendonck, & Hiel, 2006; Christoffel, 2006; Liefooghe, Vandierendonck, Muyllaert, Verbruggen, & Vanneste, 2005). In this way, participants are prevented from rehearsing the information in the main task, because their verbal working memory is occupied by the articulation of the words. When the studies want to increase the distraction level, they increase demand in the secondary task by requesting participants to repeat more complex items. For instance, Neath, Farley, and Surprenant (2003) asked participants to say "1-2-3" over and over again during the whole encoding session not a single word like "the". Another common divided attention method is to just give participants an irrelevant sound as a concurrent task. This irrelevant sound might be a narrative speech or another isolated sound (Colle & Welsh, 1976). Participants are given a sound with the main task, but unlike dual paradigm studies, this time, they are told that they will not be asked to remember anything about this sound, so they are asked to ignore this sound and to just focus the main task. One of the common examples for this method is to present participants with irrelevant speech while they are performing another task (Franssen, Vandierendonck, & Hiel, 2006; Neath, Farley, & Surprenant, 2003). Then, participants' performance in the irrelevant speech condition is compared to the performance of participants who completed the task without the presentation of irrelevant sounds. The findings showed that irrelevant speech reduces the memory accuracy about % 30 to % 50 (Ellermeier & Zimmer, 1997) and its effect is consistent and reliable in studies within-subject design (Jones, Macken, & Mosdell, 1997) and between-subjects design (Hellbrück, Kuwano, & Namba, 1996).

Up to this point, in all studies, participants undertake a main task, accompanied with another task. In the secondary task, they either disregard the given sound, or follow some instructions with this sound, or they are asked to repeat a word. The purpose of all kind of concurrent task is to prevent participants from rehearsing the main items. The findings typically show that divided attention leads to worse memory performance than full attention condition. Even when the secondary task changes, divided attention impairs cognitive rehearsal processes and thus memory accuracy.

1.3 The Effect of Divided Attention on Metamemory Processes

Memory is operationalized as a series of processes in which information is encoded, stored, and retrieved (Metcalfe & Dunlosky, 2008). As for metamemory, as indicated in its name, it can be defined as the monitoring, controlling, and regulation of all these memory processes. More specifically, it focuses on people's heuristics or predictions about how likely they will access the specific information during a specific period of time (Metcalfe & Dunlosky, 2008). For instance, a student, while studying for an exam, needs his or her metacognitive skills in addition to cognitive skills. For instance, s/he needs to think about how much to study, what s/he knows or what s/he does not know, his/her cognitive capabilities, and which cognitive strategies to use. The answers to all these questions correspond to metamemory. In the literature, there are three studies that have investigated the relationship between divided attention and people's memory predictions.

One major study that investigated the relationship between metamemory and divided attention was conducted by Kelley and Sahakyan (2003). The aim of this study was to investigate the difference between younger and older adults' memory monitoring. More specifically, researchers aimed to find out whether older adults' lower accuracy in memory predictions is caused by their poor working memory that is required for making these memory judgments. Thus, in order to test this hypothesis, they formed three between-subjects groups, which were younger adults with divided attention, older adults with full attention and younger adults with full attention. First of all, as the main task, all participants were given a list of word pairs and they were told that they would have to remember these word pairs in a subsequent memory test. However, in order to occupy working memory of younger adults, in one condition, they were given a distractor task while they were completing the main task. The distractor task was a demanding auditory task in which participants were asked to listen to numbers given through the headphones and to press the specified button when they heard three odd digits consecutively. Younger adults in the full attention condition and older adults completed the main task without focusing on a secondary task. Later, all participants were requested to complete a distractor task in order to eliminate recency effect. After the study and the distractor phases were completed, all participants were given a cued-recall test. In this test, participants were given one of the words from pairs as a cue and the other one was requested to recall. After each question was answered, they were instructed to say how they were sure in their response, by using a 0-100 scale. Then, the accuracy of younger adults' memory predictions on both conditions was compared with older adult's accuracy of memory predictions. The study showed that younger adults in the divided attention condition and older adults in the divided condition and older adults in full attention condition showed lower memory scores and lower accuracy in memory predictions, compared to younger adults in the full attention condition. In other words, this study showed that in addition to its detrimental effect on memory performance, divided attention also influences memory evaluations negatively.

The second study about the effect of divided attention on people's memory judgments was conducted by Barnes and Daugherty (2007). In order to see the effect of divided attention on metamemory, researchers formed two groups in a between-subjects design. In one group, the distracting task was given during the judgment phase. In the other condition, participants were presented the distracting task during the encoding phase. Participants were randomly assigned one of these conditions.

As in Kelley and Sahakyan's study (2003), participants were presented a word list to study for a subsequent memory test. In the divided attention condition, participants were asked to categorize the words given via headphones as either "man-made object" or "non-man-made object" by pressing the specified buttons while studying the words displayed on a screen. The words presented over the headphones and on the screen were different. After the study part was over, researchers instructed participants to make a global confidence rating by asking how many words they thought that they would remember in the upcoming memory test. In contrast to the study of Kelley and Sahakyan (2003), participants made their judgments prospectively, before they took the memory test. Then, in the test phase, participants were asked to make free recall, and given four minutes to write down the words that they remembered from the studied word list. As predicted, they found that people were sensitive to the effect of divided attention they gave lower JOLs in this condition than participants in the condition of full attention at encoding. They found that if the secondary task were presented to participants during the encoding, participants gave different judgments in the divided attention condition than in the full attention condition. That is, the secondary task has an effect on memory predictions when it is given during encoding phase. However, in contrast to their prediction, if the distractor task was presented in the judgment phase, participants' scores in full attention and divided attention conditions were not significantly different. Even if this study showed that divided attention during encoding phase affect memory judgments, results from the condition in which the secondary task was given in judgment phase contradict with these results. That is, the findings of this study showed that concurrent task given in the judgment phase does not influence people's memory evaluations.

Another study was conducted by Sacher, Taconnat, Souchay, and Isingrini (2009). In order to test the effect of divided attention on memory predictions, they formed two groups. Both groups experienced divided attention and full attention in a within subjects design. That is, in one group, participants experienced the divided attention condition at first and later full attention condition. The other group experienced these conditions in the reverse order. However, participants waited 7-8 days between these conditions.

During the encoding part, participants were presented a word pair list to recall later. As the competing task, participants were asked to listen to the numbers given over headphones and to press a specific button when they heard an even number. Later, participants were asked to recall the words in a cued-recall test.

After participants completed the whole recall test, the cues of the words that participants could not remember in the memory test were presented again, and participants were asked whether they felt that they knew the correct answer. By asking them whether they would be able to recognize the target word later, they have assessed specifically the feeling of knowing (FOK), a different type of metacognitive judgment.

The result of the study showed that regardless of the order of the attention type condition, participants were significantly less accurate in their memory judgments for the words which were presented in the divided attention condition, compared to words in the full attention condition.

1.4 Shortcomings of The Previous Studies

First of all, all previous divided attention studies investigating metamemory processes measured people's judgments in a retrospective way. In other words, participants made their judgments after they completed the encoding phase. That is a shortcoming for two reasons. First of all, there was a time lag between encoding and judgment phase. Because of this time lag, participants might have forgotten how divided attention actually had affected their memory and they might have made their judgments based on their preexisting theory about the effect of attention on memory performance. Koriat (1997) stated that when participants make retrospective judgments, they might not remember the cues for every word; thus, their judgments are more likely to reflect guessing than online subjective difficulties (Koriat, 1997). Secondly, because divided attention task was given to participants during encoding and they made their judgments later, memory judgments were not requested under distraction. Thus, significant results showed that people are aware of the effect of divided attention task on their memory performance. This might be the reason as to why they gave lower judgments under divided attention condition, but it is not obvious that the same results would be obtained if participants were asked to predict their memory performance during encoding, while they are also doing a secondary task. In other words, divided attention seems to influence actual memory performance, but it may not necessarily influence people's predictions about their memory performance if tested during actual encoding phase.

Second shortcoming might be an artifact of using aggregate memory judgments. As stated before, Barnes and Daugherty (2007), in their study, used aggregate judgments method to assess participants' memory predictions. There are two main testing methods for memory judgments, which are aggregate judgments and item-by-item judgments. If memory judgments are obtained cumulatively, it is called aggregate judgments. In other words, if participants are requested to make judgments about their general memory performance after they have completely finished studying the whole list of items, this judgment method is defined as global or aggregate judgment (Metcalfe & Dunlosky, 2008). While asking participants to make a global judgment, they are mostly asked that "How many words do you think that you will recall/recognize from this list on the upcoming test?" Their answer is defined as the number of words that they think they will remember in the test.

The other testing way of memory judgments is through item-by-item judgments-of-learning. Unlike aggregate judgments-of-learning, this time, the judgments are constrained to one specific item. In other words, people do not make a judgment for their general memory performance; in contrast, they evaluate their performance for each item. For instance, in the studies using this method, participants are presented words one by one to study for upcoming test; but this time, after each item is presented, they are requested to make judgments for that specific item with the following question “how likely are you to remember/recognize this specific item in the upcoming memory test on a scale from 0 to 100?”

When two testing methods are compared, the findings of previous studies revealed that people consider whether they are familiar with the domain of the task rather than the cues of newly studied task while making aggregate judgment (Glenberg, Sanocki, Epstein, & Morris, 1987). Consequently, when people are requested to make aggregate judgment, they mostly are less accurate in their judgments by underestimating (Mazzoni & Nelson, 1995) or overestimating (Lichtenstein, et al., 1982) their performance. Also, usually, aggregate judgments are done retrospectively. Thus, they might evaluate their memory performance based on their recollected experience rather than based on online subjective difficulties. However, in the item-by-item judgment, people make online monitoring and utilize the cues and characteristics of every item while making judgments. For that reason, aggregate judgment is considered less diagnostic of subjective difficulties, because participants cannot use online difficulties as a cue for every item in the list (Mazzoni & Nelson, 1995).

The last but most importantly, all previous studies agreed that people under divided attention condition make less accurate memory judgments compared to under full attention condition, but none of the studies mentioned above showed that the effect of divided attention on judgments is relative or absolute. Put differently, there is no any study showing why people overestimate or underestimate their performance under divided attention condition. There might be two possible reasons for that.

One is that people might just be sensitive to the effect of divided attention on their judgments and that is why they make lower judgments. The other possible reason is that people use a baseline while making memory evaluations. In other words, they might compare their performance under divided attention condition with respect to their performance under full attention condition. Thus, the main aim of the current study is to understand whether divided attention affects metacognitive judgments in an absolute or relative manner. In order to see whether people use the silent condition as a baseline while monitoring their performance in divided attention condition, one group of participants should be exposed to both conditions in a within subjects design, and their scores should be compared with participants from other two groups; the pure divided attention group and the pure full attention group to see if there is a significant difference between those groups in terms of memory evaluations. In other words, between and within subjects should be compared in terms of JOL scores. However, none of previous divided attention studies made this specific comparison to see if there is a difference. They used either between subjects (Kelley & Sahakyan, 2003; Barnes & Daugherty, 2007) or within subjects (Sacher et al., 2009). In the Sacher et al.'s study, participant experienced both divided attention and full attention conditions. However, because there was a time gap with 7-8 days between the conditions, it is not a good way to find out whether or not people compare divided attention and full attention conditions while making memory predictions for these conditions. In other words, even if all participants experienced both attention conditions, because there was a long time gap between these sessions, we cannot deduce from this study whether people use one of the attention condition as a baseline while predicting their memory performance in the other condition. During the 7-8 days, they might have forgotten the actual detrimental effect of divided attention on their memory or the useful effect of silence on their memory. Also, as control condition, they did not use pure divided attention and pure full attention condition to compare those groups.

McDaniel and Bugg (2008) investigated the effect of list composition on memory performance. In their work, they reviewed previous studies that used both within and between lists and compared them in terms of recall performance. The reviewed studies contained many different encoding phenomena, such as the frequency effect (Gregg, Montgomery, & Castaño, 1980), the bizarreness effect (McDaniel & Einstein, 1986) and the generation effect (Hirshman & Bjork, 1988). They found that the effect of encoding phenomena on recall varied depending on the design that was used. In other words, if the encoding condition varies within the list, encoding phenomenon typically reveals a significant difference between the conditions for recall. For instance, if participants are given bizarre sentences with common sentences within the same list, this makes the bizarre sentences more prominent. Thus, in the subsequent memory test, bizarre sentences are recalled better than the common sentences. However, if these words are presented in different list separately, bizarreness effect is eliminated and sometimes it may even show a reversed result, with common sentences revealing better memory performance than bizarre sentences.

McDaniel and Bugg’s review study (2008) showed that list composition is an important factor for investigating the effects of encoding conditions on recall performance. The effect of list composition on actual memory performance has been studied extensively in literature. Yet, up-to-date, the use of list composition with regard to metacognitive processes is seldom. One study conducted by Susser, Mulligan, and Besken (2013) investigated the list composition effect on metamemory processes.

Previous research showed that while making predictions about memory performance, people use many cues and/or heuristics (Koriat, 2007). For instance, they use how easily they learned the material (Koriat, 2008), how easily they retrieve the items from their semantic memory (Benjamin, Bjork, & Schwartz, 1998), or how easily they perceived the material (Rhodes & Castel, 2008). That is, people take into consideration the fluency of the task in terms of perception, encoding, or retrieval during the judgment process (Alter & Oppenheimer, 2009). However, there are also many studies showed that cues sometimes mislead people while making memory judgments (Koriat & Bjork, 2005; Castel, McCabe, & Roediger, 2007). In other words, these cues might not be diagnostic of actual memory performance. For instance, in one study, researchers gave a words list to participants in either large or small font and compared their scores in terms of memory predictions and actual memory performance (Rhodes & Castel, 2008). The findings showed that participants who took the words in large font gave higher judgments compared to small font condition. However, in contrast to their expectations, memory scores did not significantly vary in two conditions. Susser, Mulligan, and Besken (2013) investigated whether list composition might have an effect on this discrepancy. In other words, this study argued that if participants experienced both large and small fonts in one condition, they would not overestimate or underestimate their judgments, because they would use one condition as a baseline while predicting in other condition. More specifically, this study argued that memory evaluations are relative in nature. Therefore, this study is the first study that used both within and between conditions. More specifically, Susser, Mulligan and Besken (2013) formed two between subject conditions and one within subject condition and investigated the list composition effect on memory predictions by comparing these between and within conditions.

In order to test their hypotheses, they conducted three experiments. In these experiments, they used different manipulations in order to test whether perceptual fluency effect on memory predictions is relative or absolute. In the first experiment, they used the same manipulation with Rhodes and Castel's study (2008) and gave participants either small (18-point) or large (48-point) font words to study and instructed participants to recall these words in a subsequent memory test in between conditions; pure-list small and pure-list large. In the mixed-list condition, participants experienced both large and small font words. Later, these conditions were compared in terms of memory predictions. As predicted, the findings showed that participants gave significantly higher JOLs for large font words than small font words in the mixed condition; however, there was no difference in judgments of learning for pure lists. In order to replicate the results of the first experiment, researchers conducted other two experiments and changed the manipulations. In the second experiment, participants were presented either intact words or words with missing parts to generate via headphones. In the third experiment, they gave participants either intact or incomplete words to generate on the computer screen. The results of second and third study were similar to the first study and showed that list composition had an effect on memory predictions. In other words, this study revealed that if people experience different encoding conditions in the same list, they use one of them as a baseline during memory judgment, but this does not happen in a between-subjects design.

Susser, Mulligan, and Besken's study is the only study in the literature that systematically investigates the effect of list composition on memory predictions. The current study aimed to investigate the effects of list composition in relation to divided attention. In parallel with the Susser, Mulligan, and Besken's (2013) study, it was expected that only if when people exposure to the noise and this task is removed after a while, they can more clearly differentiate the detrimental influence of noise on their memory performance and they can reflect this to their predictions. However, it was predicted that if participants exposure this noise during the whole learning process or study the task with a complete silence, they may not realize that silence is beneficial to memory performance or that noise is detrimental to actual memory performance, because there is no other condition to take as a reference while making judgments. Thus, in the present study, this issue was questioned.

1.5 Overview of the Present Study

The aim of the current study is to investigate whether the effect of divided attention on memory evaluations is relative or absolute. More specifically, the purpose of the study is to test whether people make comparisons while making judgments about their subsequent memory performance when they are exposed to full and divided attention tasks. To test this hypothesis, we used both a within-subjects condition and two between-subjects conditions. That is, one group of participants experienced both full attention and divided attention conditions while they were encoding the materials and making judgments for those materials. In the other two conditions, participants just experienced either pure full or pure divided attention conditions. Later, the difference between pure attention conditions and mixed attention condition were compared in terms of actual memory performance and memory predictions. As stated before, except for Sacher et al. (2009), all previous studies investigating the relationship between memory predictions and divided attention looked at the difference among between-subjects groups, in which participants experienced either full attention condition or divided attention condition. Thus, their results do not show whether or not people use a baseline while making judgments because they just experience one of the conditions, full attention or divided attention condition. Thus, if participants are allowed to experience these conditions comparatively, the effects of full attention and divided attention, they cannot compare their condition with the other one directly. They might use their preexisting belief about the effect of divided attention on their memory predictions while making these judgments.

Even with Sacher et al. (2009), it is questionable whether participants use one of the conditions as a baseline to predict their performance, because in this study, there were seven or eight days between two sessions. All participants experienced both divided attention and full attention conditions, but because there was a long time lag between two sessions, people might not have compared two attention conditions while making judgments. In other words, people might have forgotten the actual distracting effect of the secondary task, or the actual facilitating effect of full attention on memory Moreover, all previous divided attention studies, including the study of Sacher and his colleagues (2009) used either between or within subjects but there is no any study using these groups in the same study and comparing within and between subjects. In the present study, like Susser, Mulligan, and Besken (2013), we used both between and within subjects, because it is expected that being exposed to distractor continuously or partially might moderate the effect of attention on people's predictions. McDaniel and Bugg (2008) stated that if the encoding condition is varied in the list (divided vs. full attention in our study) the actual effect of encoding condition changes. Thus, in the current study, two between subject groups, which are pure full attention and pure divided attention, and one within subject group were used. In parallel with previous studies' results, it was expected that participants would give different judgments for divided attention condition and full attention condition, but it is predicted that within-subjects variation would be significantly more powerful than between-subjects variation. In other words, it is predicted that participants become more sensitive to distraction in their memory predictions, because they have just experienced both full attention and divided attention condition in the within subjects condition compared to between subjects groups in which people only experience either full attention or divided attention conditions.

Also, by testing our question, we also took into consideration the shortcomings of the previous divided attention studies and we asked participants to make item-by-item and prospective judgments rather than aggregate and retrospective judgments.

1.6 Variables

1.6.1 Independent variables

1.6.1.1 Attention Type

Attention condition was the independent variable of this study that assesses people's attention level. In order to manipulate this variable, we used irrelevant speech as a secondary task, presented to the participants over the headphones. Participants were given either the sounds of two women talking at the same time, played to the participants backwards to get a speech-like meaningless noise (Experiment 1) or heavy traffic noise from India (Experiment 2). This independent variable had two levels, which were full attention and divided attention conditions. Divided attention condition was manipulated by giving participants a secondary task while they were busy with the main task. In the full attention condition, participants were not given the secondary task; they were just asked to focus on the main material.

1.6.1.2 List Composition

The second independent variable of the current study was list composition. There were three different groups, which were pure divided attention, pure full attention and mixed attention conditions. In the pure divided attention group, participants were presented with the secondary task throughout encoding phase. In the pure full attention condition, participants were not given the secondary task; they were just asked to focus the main material through out the encoding phase. In the mixed attention condition, participants received the secondary task in a within-subjects design. That is, while they were busy with studying the word list, the recording was given off-and-on during the entire encoding session.

1.6.2 Dependent Variables

1.6.2.1 Free-Recall Performance

In the study part, participants were given forty words to study. The first four words and the last four words were taken out in order to eliminate primacy and recency effects on recall, leaving a total of thirty-two critical words that participants were tested on. In the recall test, participants were requested to write down the words that they remembered from this list. Thus, in the pure divided attention condition and pure full attention condition, memory scores were defined as the number of remembered words divided by the total number of words in the list (32). If they were able to retrieve all target words from the list, their proportion correct recall would be 32/32 =1.00. If they recalled only 16 words, their proportion correct recall would be 16/32 = .50

In the mixed attention condition, participants' memory scores for divided and full attention parts were calculated separately. Thus, in this condition, every participant had two memory scores that were divided according to their attention type. Because in this condition, while the half of the critical words were presented with the distractor sound, the other half were given without this sound; each memory scores were evaluated over sixteen words. Thus, memory scores of participants in this condition were defined as the average recall scores that participants remembered correctly for each attention type.

1.6.2.2 Judgments of learning scores

Participants were asked to make judgments-of-learning for each word immediately after the each word was presented by using a scale. This scale ranged from zero to one hundred and the more point means that they thought they would more likely recall that specific word in the subsequent memory test. Thus, in the pure full attention and pure divided attention condition, judgment of learning scores was defined as the average scores of every participant that they gave for all critical words. In the mixed attention condition, participants' scores were divided according to attention condition. In other words, in the mixed attention condition, participants' scores from full attention and divided attention parts were calculated separately. Thus, in this condition, participants had two separate judgment scores, which were full attention and divided attention's judgment scores, and each of them was defined as the average judgments scores that were obtained over half of the total critical words.

1.7 Hypotheses

1.7.1 The effect of divided attention on recall performance

Hypothesis 1: In parallel with all divided attention studies, a main effect of divided attention on recall performance is hypothesized. It was hypothesized that participants under full attention condition, regardless of within or between subjects, would recall more words in the subsequent memory test compared to participants under divided attention condition.

1.7.2 The effect of divided attention on judgments of learnings

Hypothesis 2: In parallel with the previous findings, in the current study, it was also expected that participants under full attention condition, regardless of within or between subjects, would predict to remember more words from the full attention condition than the divided attention condition.

Hypothesis 3: In the current study, it was hypothesized that the difference between JOL scores of within subject group for divided attention and full attention would be significantly higher than participants in the between subjects group. More specifically, because in the within subjects group, participants experienced both full attention and divided attention, they would use full attention as a reference or baseline and would realize the disruptive effect of divided attention on their memory more and would give significantly lower JOLs for divided attention parts compared to other participants who did not have a chance to compare those two attention conditions. If participants are not using a baseline for making judgments for different conditions, the difference between within and between judgments should not be significant.

CHAPTER II

EXPERIMENT I

2.1. Method

2.1.1 Participants

Thirty participants were recruited from Bilkent University via convenience sampling method. The participants were selected from individuals between the ages of 18 and 30. Also, because during the experiments, participants were presented words on computer screen and sounds with the headphones, participants were asked whether they had any problem with hearing and vision and participants were selected from with normal vision and hearing. Participants either participated voluntarily for research experience or received credit for their participation.

2.1.2 Materials

Forty words that were given in the study session to the participants were taken from the pool developed by Göz (2003). This pool includes all kinds of words like nouns, verbs, conjunctions, and adverbs. However, in the current study, only nouns were used. Emotional and abstract nouns were not included. In order to eliminate the familiarity and rareness effects on memory performance, the words used in the study were not chosen from very rare and very common words. Thus, for the present study, words whose frequency values change from 70 to 105 were used. Ten words were selected from the words with the value ranging from 70 to 79, the other ten words were selected from 80 to 89, the others were between the range of 90 to 99; the last ten words were be chosen from 100 to 105. In order to eliminate primacy and recency effects, four words that were presented at the beginning and four words from the end of the list were excluded from all analyses; leading to analyses with 32 critical words. These filler words and their order have never changed across the conditions. In the study session, participants were presented all the critical words in a random order. Also, in the mixed attention condition, words were counterbalanced among the divided attention and full attention levels. To explain, the words that were presented in the divided attention condition to some participants were presented in the full attention condition to other participants.

For divided attention and mixed attention conditions, the procedure, which was used in Hygge, Boman, and Enmarker (2003), was employed. In order to distract participants' attention, as in the study of Hygge and colleagues, an irrelevant speech was given them via headphones with the sound level of 62 dBA 2 m. In order to obtain this sound level, a program that measures dB level of the sounds was used. Also, in order to make the irrelevant speech meaningless, during the recording, two people read different short stories at the same time. These stories were obtained from the high school curriculum. Later, as in Hygge and colleagues' study, this recording was played backward to the participants in order to get a noise without discernible meaning.

2.1.3 Design

In the current study, there were two independent variables, which were attention type and list composition.

The levels of attention type were full attention and divided attention. In divided attention condition, participants were exposed to distracting sounds while encoding the materials. In the full attention condition, they completed their task with no exposure to distractor.

The levels of list composition were pure list conditions and mixed list condition. In the mixed list condition, half of words were accompanied by distracting sound. For the other half of the list, the words were presented with no exposure to sound. In the mixed list condition, whether participants were exposed to distracting sound or not was determined randomly, with the prerequisite that no more than two trials of the same type were presented consecutively. Thus, in the mixed condition, the levels of attention type (sound and no-sound) were manipulated within subjects. In the pure-list conditions, participants studied the whole word list either with the distractor task or without the distractor sound. Thus, for the pure-list conditions, levels of attention were manipulated between subjects. All participants were randomly assigned to one of three groups: pure- full attention condition, pure-divided attention condition and mixed attention condition. There were ten participants in each condition.

The first dependent variable of the present study is judgments-of learning (JOL) scores. For JOL scores, same scale with previous studies (Castel, McCabe, & Roediger, 2007; Mueller, Dunlosky, & Tauber, 2015) was used. In order to assess this variable, participants were asked to make memory predictions with the scale ranging from zero to one hundred for each word one by one after each was presented. By rating their confidence, they used a scale ranging from 0 to 100. On this scale, the score of 0 means, “I definitely won’t remember this word on the later test”, whereas the score of 100 corresponds to “I will definitely remember this word on the test”. Thus, lower scores signify lower confidence for the target word, but the higher scores mean higher confidence to recall the target word on the subsequent test. Participants’ average judgments of learning for each condition is denoted as the dependent variable.

The second dependent variable is participants’ proportion of correct recall on the free recall test. Because the memory test was a free recall test, participants’ total score in each condition was determined by summing up the words that they recalled from the list. For each word that participants correctly recollected, they got one point. In pure list conditions, recall scores were divided by the total critic number of words (32). In the mixed attention condition, participants’ recall scores were computed separately according to their attention type. In this condition, number of words correctly recalled was tallied up and divided by the half of the total critical words (16).

2.1.4 Procedure

There were three phases of the experiment: study phase, distractor phase, and test phase.

In the first phase of the study, all participants, regardless of their attention condition, were instructed to study a list of words for an upcoming test. Each word was presented at the center of the screen to the participants in random order for 3 seconds and they were asked to use all this duration to study the word. After each word was presented, participants were instructed to rate their confidence about the likelihood of recalling this word in a subsequent memory test. By rating their confidence, they used a scale ranging from 0 to 100. In this scale, 0 indicates that they definitely would not remember this word on the test; the score of 100 indicates that they definitely would remember this word. They were instructed to use whole scale by rating their confidence. Participants were given four seconds to write down their answers on screen by using keyboard.

After completing the study phase, all participants, were given a distractor task to eliminate the recency effect on test phase and to ensure that they did not maintain the information in their working memory. In this part of the study, participants were asked to solve some arithmetic problems (i.e. 157x3=?, 58+89=?) for 3 minutes.

After the distractor phase, participants moved on the test phase. In this phase, all participants were requested to try to recall as many of the words as they could from the studied list and type them via the keyboard. They were given a total of five minutes to complete this phase, but they could self-terminate the free recall phase by pressing ESC.

2.2 Results & Discussion

There were two independent variables in this study, which were attention type and the list composition. The levels of this attention condition were full attention and divided attention. The second independent variable was list composition. Attention type was manipulated either in a between or a within fashion, producing three conditions, pure full attention, pure divided attention, and mixed-list conditions. In order to compare the effects of list composition, Erlebacher's (1977) method was performed. Erlebacher's system is an analysis technique, which is performed to see whether there is an interaction between the list composition and another substantive independent variable. Thus, in this study, in order to see whether the effect of substantive independent variable, which was attention type in the present study, varied dependent on list composition on both dependent variables (memory performance and memory predictions), Erlebacher's analysis technique was performed. Thus, list composition was treated as another factor in addition to the existing independent variable, which was the attention type. Therefore, in this study, 2 (list composition with the levels of within and between groups) x 2 (attention type with the levels of divided attention and full attention conditions) mixed ANOVA was performed to assess JOLs and recall performance of participants.

2.2.1 Judgments of Learnings (JOLs)

Some participants could not enter their JOL scores in the allotted time Thus, before conducting the results, these data, which constituted the .01% of total JOL scores, were excluded from the analyses.

In the divided attention condition, the mean JOL was 57.99 with a standard deviation of 22.03. In the full attention condition, the mean JOL was 58.79 with a standard deviation of 17.67. The main effect of attention, contrary to expectations, attention did not have significant effect on participants' JOLs, $F(1, 27) = 4.21$, $MSE = 7.716$, $p > .005$.

As for the independent variable of list composition, in the pure attention conditions, which were pure full attention and pure divided attention group, the mean JOL was 53.37 with a standard deviation of 20.40. In the mixed attention condition, the mean JOL was 63.34 with the standard deviation of 18.17. The main effect of list composition is not significant, $F(1, 25) = 4.24$, $MSE = 1177.468$, $p > .005$.

Finally, the findings showed that participants gave higher JOLs if the word was presented with the distracting sound ($M = 65.83$, $SD = 18.96$) compared to words were presented without the distractor ($M = 62.12$, $SD = 18.11$). The results of the comparison of between subjects groups revealed that people if participants learned the whole list with a distracting sound, they gave lower JOLs (M = 51.42.12, *SD* = 23.68) compared to participants who studied the words in a silent condition (*M* = 55.46, *SD* = 17.34) (see Figure 1).

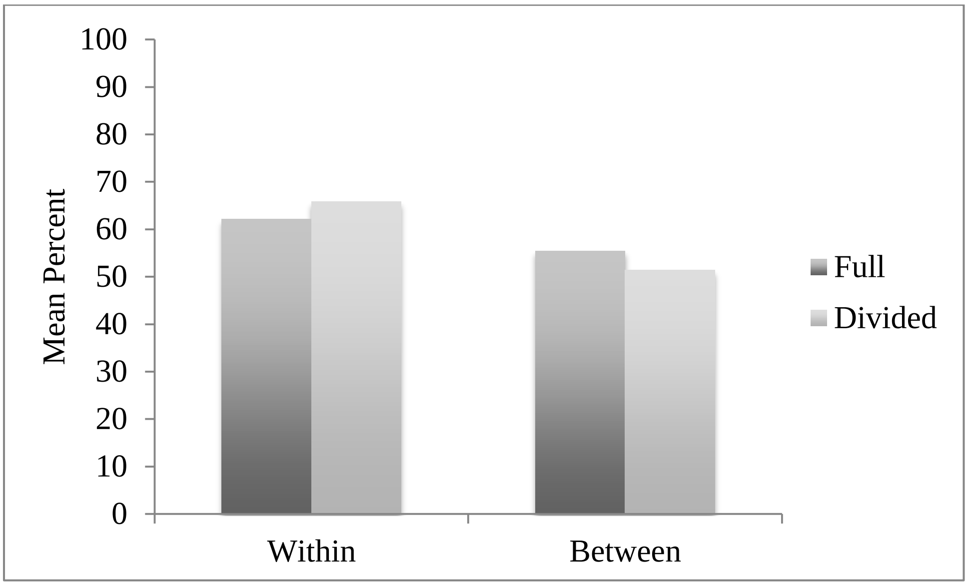

Fig.1 Mean Judgments of Learning (JOLs) in within (mixed condition) and between (pure divided and pure full attention conditions) groups of Experiment 1.

As for the interaction effect of list composition and attention type on memory predictions, the findings showed no significant relationship between these variables $F(1, 27) = 4.21$, $MSE = 126.030$, $p = .571$. We expected that the difference between participants' JOL scores for divided and full attention levels in the mixed attention condition would be significantly higher than the difference between JOL scores of participants in pure divided attention condition and pure full attention condition. However, the findings did not support our hypothesis and we did not find significant difference among within and between groups' memory predictions. In order to examine more details about the Erlebacher's analysis, please see the Table 1 and its explanation.

Table 1.

The Summary of the Analysis of Variance for JOLs of Experiment 1

Source of Variation	*df*	*SS*	*MS*	*F*	*p*
Attention type (A)	1	7,716	7,716	.020[a]	>.05
List composition (L)	1	1177,468	1177,468	3,041[b]	>.05
A X L	1	126,030	126,030	.325[a]	>.05
s/W	11	6939,091	630,826		
Subjects X A/W	11	623,088	56,644		
s/A[B]	22	9475,187	430,690		

Note. In order to analyse between and within groups, two data sheet were created. In one of them, the data were organized according to the variable of attention type and its three different levels, which were pure full attention, pure divided attention and mixed attention conditions. In this data sheet, JOL scores and recall scores were divided as their attention type, either full or divided attention. Thus, participants' scores in the mixed condition were split into two according to attention type. Thus, while participants' memory scores and prediction ns in the pure attention conditions were out of total critical word numbers, in the mixed attention condition, the scores were calculated separately for the words from divided and full attention parts.

The second data sheet was arranged according to the other independent variable, which was list composition. As stated before, the variable of list composition had two levels with between and within conditions. This time, in order to see the mixed attention's effect on dependent variables, memory scores and JOL scores were separated according to full attention and divided attention parts.

After constructing according to independent variables, in order to analyse data, the following steps were performed.

- First of all, the second data were opened in SPSS and a univariate analysis with JOL scores as dependent variable and with list composition and attention type as independent variable was performed. In the “between subjects effects” table, the lines of “list”, “attention” and “interaction” were copied to ANOVA table.
- Secondly, the first version of the data arrangement was opened in the SPSS and a repeated measure of ANOVA was run by restricting the data with only “mixed condition”. Then, in the “Tests of Between-Subjects Effects” & “Tests of Within-Subjects Effects”, error lines were constituted the fourth and fifth lines of our ANOVA table.
- Lastly, the second version of the data was opened again in the SPSS. This time, since we were interested the between subjects, only between groups were used and one-way ANOVA with JOL scores as dependent variable and attention type as independent variable were performed. Then, “wıthin groups” line was copied to ANOVA table to constitute the sixth line of the table.
- With these steps, we got the sum of squares (*SS*), degrees of freedoms (*df*) and mean squares (*MS*) of the ANOVA table. Now, in order to get the F scores, the following steps were carried out.
  - First of all, the denominator *MS*1 and *MS*2 were calculated. The calculations for each one is as follows.

        - For denominator *MS1*, the average of *MS* (s/A[B]) and *MS* (subjects X A/W) from the ANOVA table was calculated. For *MS2*, the average of *MS*(s/A[B]) and *MS*(s/W) was calculated.
    - Secondly, degrees of freedom scores (*df*1 and *df*2) were computed as follows.
        - For *df*1, the square of the sum of *MS* (s/A[B]) and *MS* (subjects X A/W) was divided by the sum of the square of *MS* (s/A[B]) divided by *df* (s/A[B]) and the square of MS(subjects X A/W) divided by *df*(subjects X A/W).
        - For *df*2, For *df*1, the square of the sum of *MS* (s/A[B]) and *MS* (s/W)was divided by the sum of the square of *MS* (s/A[B]) divided by *df* (s/A[B]) and the square of *MS*(s/W) divided by *df*(s/W).
    - Finally, in order to see if there is main effect of independent variables and the interaction effect, based on these *df* scores, the critical F values were from the F ratio table.

The same procedure was also followed for the second dependent variable, which is the actual recall scores' of participants and for the second experiment.

2.2.2 Recall Performance

Participants' recall scores were computed by summing up the number of words that they recalled in the memory test and dividing these by the number of critical thirty-two words in the pure list conditions. Thus, recall scores were defined as the proportion of number of recalled words to thirty-two words. In the mixed-list condition, proportion of correct recall was tallied up separately for each condition and was divided by sixteen, the total number of words in each condition. Therefore, for the mixed list condition, two separate proportions of correct recall were obtained.

The comparison analysis showed that participants who learned the words in the distracting environment recalled less words (*M* = 0.29, *SD* = 0.13) compared to participants who took the words without the distractor (*M* = 0.30, *SD* = 0.14). However, this difference between participants' recall score was not significant, $F(1, 3) = 10.13$, $MSE = .003$, $p > .05$.

Moreover, if participants assigned to the mixed-list condition remembered less words in the memory test (*M* = 0.27, *SD* = 0.15) compared to participants in the pure divided attention condition and in the pure full attention condition (*M* = 0.30, *SD* = 0.13). However, the effect of list composition did not significantly influence participants' recall performance, $F(1, 7) = 5.59$, $MSE = .008$, $p > .05$.

As for interaction effect, we expected that participants in the mixed attention condition would recollect significantly less words in full attention level (*M* = 0.28, *SD* = 0.16) than participants in the divided attention level (*M* = 0.28, *SD* = 0.16). Also, we predicted that this difference between two levels of mixed attention condition would be significantly higher than the difference between memory scores of participants in pure divided attention condition (*M* = 0.29, *SD* = 0.11) and in pure full attention condition (*M* = 0.30, *SD* = 0.15) (see Figure 2).

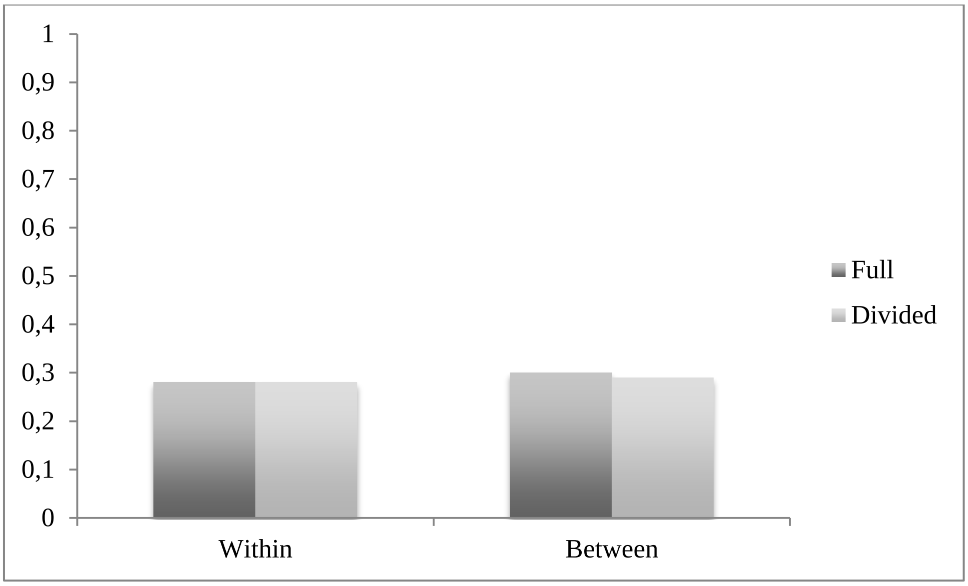

Fig.2 Recall scores in within (mixed condition) and between (pure divided and pure full attention conditions) groups of Experiment 1.

However, as it can be seen in the Table 2, the interaction effect between list composition and attention type was not significant, in contrast to expectations, $F(1, 3) = 10.13$, $MSE = .004$, $p > .05$. That is, the difference between participants' memory scores from within and between groups did not significantly vary.

Table 2.

The Summary of the Analysis of Variance for Recall Scores of Experiment 1

Source of Variation	*df*	*SS*	*MS*	*F*	*p*
Attention type (A)	1	.002	.002	.089[a]	>.05
List composition (L)	1	.008	.008	.398[b]	>.05
A X L	1	.004	.004	.181[a]	>.05
s/W	11	.319	.036		
Subjects X A/W	11	.131	.012		
s/A[B]	22	.362	.016		

In the current study, the role of attention and list composition on people's predictions about their memory performances and on their actual memory performances was investigated. In line with the previous studies, it was predicted that if participants were given a distractor task would show worse performance in the subsequent test than the participants who learned the words with no exposure to distractors. However, in contrast to predictions, attention did not influence participants' memory test scores. This result contradicts with the previous studies. As stated in the introduction part, there are many divided attention studies which revealed that if people perform a task accompanied with a secondary task, their performance on both tasks or one of the tasks drops (Neath, Farley, & Surprenant, 2003; Benjamin et al., 2000; Gaspelin, Ruthruff, & Pashler , 2013; Lozito & Mulligan, 2010; Prull et al., 2016).

In addition to the role of attention on memory performance, it was also expected that participants' memory prediction might also be influenced by whether they have been exposed to irrelevant speech or not. In other words, participants took the words with distractor might realize the negative effects of irrelevant speech and they might give lower JOL scores to the words in divided attention condition than the full attention condition. Specifically, participants assigned to the mixed-list might become aware of the contrast between full attention and divided-attention condition more readily than pure-attention groups, and the difference between the two within conditions might be more noticeable than participants who are assigned to pure-list conditions. In contrast to expectations, the results of the first study did not support this hypothesis either. The findings from some previous studies reveal that if participants are given another task at encoding phase, they make lower judgments of learning than participants who study the words without a secondary task at the encoding phase (Kelley & Sahakyan, 2001; Barnes & Daugherty, 2007; Sacher et al., 2009).

Also, it was hypothesized that if participants learned the words with a distractor task, which was given on and off would give significantly higher JOLs for the words given with the distracting sound compared to participants whom word list were given only in the distracting environment. Similarly, it was predicted that if participants took the words list with a distracting sound, which was given intermittently, would give significantly higher JOLs for the words presented in the no-sound parts compared to participants who studied the whole word list in a silent condition. In other words, experiencing the silent and sound condition did not influence participants' judgments, in contrast to the hypothesis.

The possible reason for null results might that the irrelevant speech presented to the participants was not strong enough. Thus, in the second study, we decided to increase the intensity of the sound. According to the previous findings, the effect of sound does not change according the level or intensity of sound if the distractor sound is a kind of irrelevant speech (Colle, 1980; Ellermeier & Hellbrück, 1998; Salame & Baddeley, 1987). A study done by Daee and Wilding (1977) showed that if the distractor sound is not an irrelevant speech, the intensity of the sound has an effect on increase and decrease memory performance. More specifically, high intensity sounds influences participants' memory performance more than low intensity sounds. Based on these findings, in the second experiment, the kind of sound and its intensity were changed.

CHAPTER III

EXPERIMENT 2

The result of the first experiment failed to show that attention influences actual and predicted memory performance. Also, in contrast to our hypothesis, participants' predictions from within and between subject groups were not significantly different. In the second experiment, the type of distractor sound was changed in order to see whether this would have an effect on both memory predictions and actual memory performance. As stated before, previous findings revealed that as the intensity of the sound increase, the number of words recalled in the test decreases (Daee & Wilding, 1977). However, this effect is not replicated in irrelevant speech. Thus, in the second experiment, the type of the distractor sound was changed. Again, we used the same material with the study of Hygge, Boman, and Enmarker (2003). In this study, they used a heavy traffic sound to distract participants' attention. In the present study, we replaced the irrelevant speech sound with heavy traffic sound. Also, in order to increase the effect of the distractor, its intensity was increased by increasing the volume of the distraction, compared to first study.

3.1 Method

3.1.1 Participants

Ninety participants were recruited from Bilkent University. Thus, in each condition, there were thirty participants. As in Experiment 1, participants were between the ages18 and 30, and they had self-reported normal vision and normal hearing.

3.1.2 Materials and Design

Except for the distractor task, the materials, the design and the procedure were identical to Experiment 1. In order to distract participants in the encoding phase, participants were presented with a heavy traffic sound at the level of 80 dBA 2 m. The traffic sound was obtained from a Youtube video (at the web address: https://www.youtube.com/watch?v=AtEfAcWPvps).

Ninety participants were randomly assigned to one of three conditions; full attention condition, divided attention condition, and mixed-list condition. As in the first study, the variable of attention type was manipulated as both within-subjects and a between-subjects variable.

3.1.3 Procedure

There were three phases in this experiment, which were the study, the distractor and the test phases as in Experiment 1. The procedure was identical to Experiment 1.

This time, in order to distract the participants, they were presented a heavy traffic sound over headphones.

3.1.4 Results

As in Experiment 1, attention type and list composition variables were submitted to an ANOVA, using Erlebacher's (1977) method. 2 (list composition: within and between groups) x 2 (attention type: divided attention and full attention conditions) mixed ANOVA was conducted for both recall and JOL scores.

3.1.4.1 Judgments of Learnings (JOLs)

Twenty-one JOL scores, which correspond to 0.007% of the total data, were excluded from the analyses, because participants could not enter their JOLs in the specified time.

In this study, there were two independent variables. One of them is attention type. The simple comparisons results displayed that participants in the full attention condition, regardless of its list composition, gave numerically higher JOLs (*M* = 54.71, *SD* = 21.06) compared to participants in the divided attention condition (*M* = 53.16, *SD* = 19.35). The effect of attention on participants' memory performance was not significant, $F(1, 65) = 3.99$, $MSE = 7.531$, $p > .05$.

The other independent variable in this study was list composition. The result of the study showed that participant in the mixed condition gave higher JOLs (*M* = 56.32, *SD* = 17.28) than participants in the pure attention groups, which were pure full attention and pure divided attention conditions (*M* = 51.55, *SD* = 22.55). However, the difference between pure and mixed groups was not significant, $F(1, 74) = 3.97$, $MSE = 682.157$, $p > .05$.

Finally, as it can be seen in the Figure 3, participants studied the words with a distractor sound in the mixed condition gave higher JOLs (*M* = 56.16, *SD* = 17.03) compared to participants presented without the distractor sound (*M* = 52.93, *SD* = 20.04). When we look at the between groups differences, in the pure divided attention condition (*M* = 50.17, *SD* = 21.28), gave lower scores than in the full attention condition (*M* = 56.48, *SD* = 17.82).

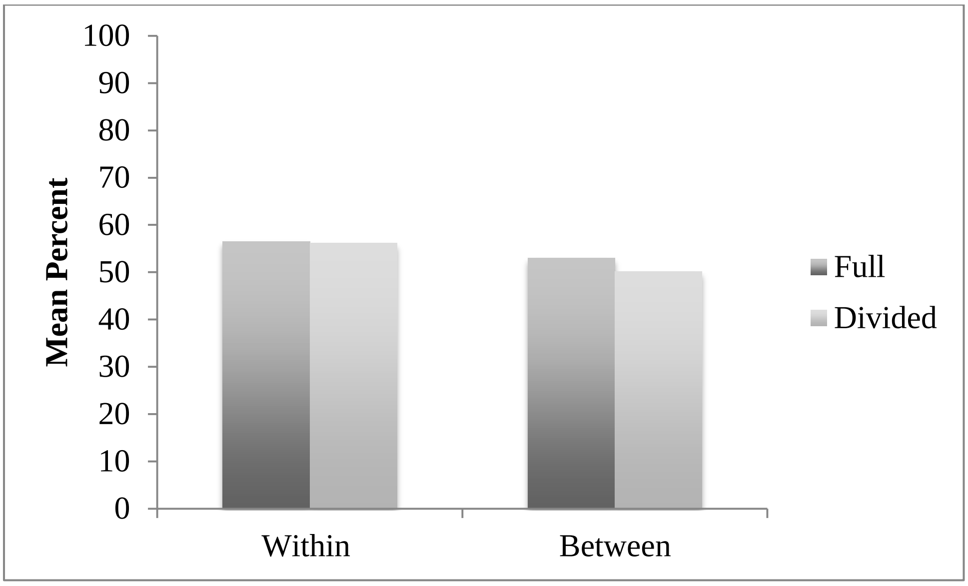

Fig 3. Mean Judgments of Learning (JOLs) in within (mixed condition) and between (pure divided and pure full attention conditions) groups of Experiment 2.

Thus, as shown in the Table 3, ANOVA results did not show significant interaction effects between the variables of attention type and list composition, $F(1, 65) = 3.99$, $MSE = 44.701$, $p > .05$.

Table 3.

The Summary of the Analysis of Variance for JOLs of Experiment 2

Source of Variation	*df*	*SS*	*MS*	*F*	*p*
Attention type (A)	1	71.531	71.531	.026[a]	>.05
List composition (L)	1	682.157	682.157	1,249[b]	>.05
A X L	1	44.701	44.701	.164[a]	>.05
s/W	29	16715.75	576.405		
Subjects X A/W	29	907.917	31.307		
s/A[B]	58	29897.2	515.469		

3.1.4.2 Recall Performance

The main effect of attention type did not have significant effect on participants' recall scores, $F(1, 77) = 3.97$, $MSE = .025$, $p > .05$. The difference between full attention ($M = 0.26$, $SD = 0.12$) and divided attention ($M = 0.28$, $SD = 0.12$) conditions was not significant.

The main effect of list composition was not significant, *F*(1, 46) = 4.05, *MSE* = .043, *p* > .05. The difference was not significant between mixed (*M* = 0.29, *SD* = 0.14) and pure attention conditions (*M* = 0.25, *SD* = 0.09).

Finally, the simple comparisons showed that in contrast the expectations, participants in the mixed condition remembered slightly less words in the full attention level (*M* = 0.26, *SD* = 0.14) compared to participants in the divided attention level (*M* = 0.31, *SD* = 0.13). The comparisons of between groups showed that in the pure full attention condition (*M* = 0.24, *SD* = 0.09), participants recalled slightly less words than in the than participants in pure divided attention condition (*M* = 0.26, *SD* = .10) (see Figure 4).

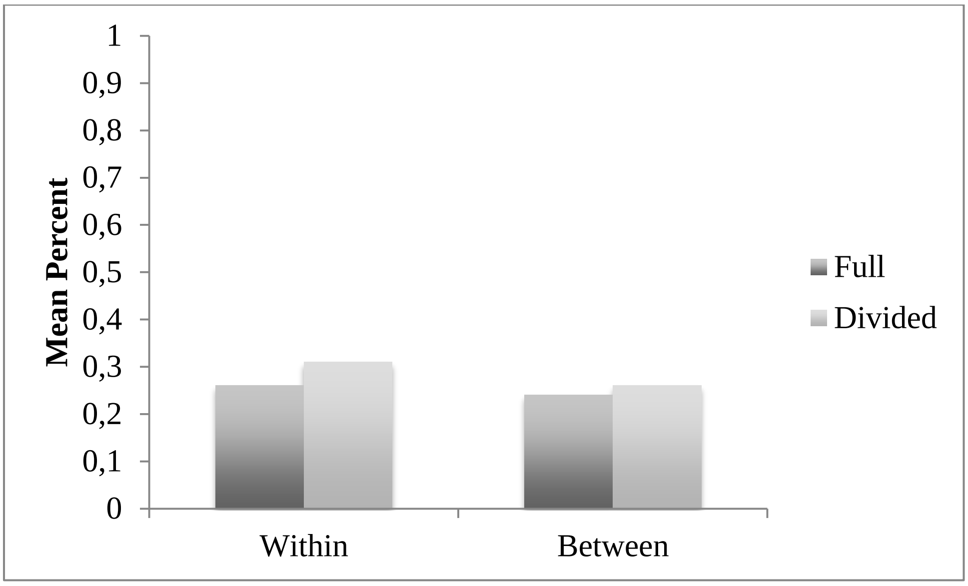

Fig.4. Recall scores in within (mixed condition) and between (pure divided and pure full attention conditions) groups of Experiment 2.

The interaction effect between attention type and list composition did not reveal significant effect on memory performance, $F(1, 77) = 3.97$, $MSE = .005$, $p > .05$.

Table 4.

The Summary of the Analysis of Variance for Recall Scores of Experiment 2

Source of Variation	*df*	*SS*	*MS*	*F*	*p*
Attention type (A)	1	.025	.025	1,732[a]	>.05
List composition (L)	1	.043	.043	1,732[b]	>.05
A X L	1	.005	.005	.358[a]	>.05
s/W	29	.906	.031		
Subjects X A/W	29	.247	.009		
s/A[B]	58	.495	.009		

CHAPTER IV

GENERAL DISCUSSION

The present study was conducted to investigate the role of attention on memory performance and memory predictions and also to see the effect of list composition on the same dependent variables. Previous studies that investigated the role of divided attention on metamemory evaluations used either between subject groups or within subjects. In the between-subjects groups, different participants are exposed to one level of the variable. Some participants study the words in full attention condition whereas the others study the words in the divided attention condition. Later, memory predictions of these separate groups are compared (Kelley & Sahakyan, 2001; Barnes & Daugherty, 2007). The other used method is the within subjects group. In this method, all participants are exposed to both levels of the variable. Thus, participants make half of their judgments under divided attention condition, and half of their judgments in full attention condition. Again, the scores from each level are compared (Sacher et al., 2009). However, to-date, there are no divided attention studies that compares between and within subject groups in order to see whether list composition has an effect on people's memory predictions. To-date, as stated before, there is only one study that investigated the effect of list composition on memory predictions, which was conducted by Susser, Mulligan, and Besken in 2013. In this study, they examined the list composition effect by creating mixed and pure lists that were manipulated in perceptually different ways. The researchers found that if participants are sensitive to perceptual differences in the list and they gave significantly different judgments for different levels in the mixed list. Also, they found that the difference between two levels of the mixed condition is significantly higher than the difference between two pure list conditions. This findings shows that people compare two levels of the list and use one of them as a baseline while making memory predictions.

Susser, Mulligan, and Besken's study (2013) shows that people are sensitive to the perceptual variation within the list and they are affected from this variation while doing memory judgments. In the current study, we investigated whether list composition is also an influential factor if the list varies in terms of attention condition. To do list, we have created mixed and pure attention groups and compared their judgment scores to examine the list composition effect.

First of all, the brief summary of the results and their interpretations will be given. Later, the limitations of the study and the suggestions to the future studies will be offered.

4.1 The summary of the findings

4.1.1 Judgments of Learnings (JOLs)

There were two hypotheses for JOL scores of the participants. The first one is that participants in the divided attention condition, regardless of the list composition, would give lower JOLs for each word compared to participants under full attention condition. The findings of both first and the second experiment did not confirm this hypothesis. The results of both experiments revealed that participants gave lower JOLs when their attention was distracted with a sound compared the under the silent condition but the difference between those conditions was not significant.

This result contradicts with the previous studies. As stated before in the introduction chapter, Kelley and Sahakyan (2001) found that if participants' attention is divided with another task, they gave significantly lower predictions compared to people who take the main task in a silent environment. Barnes and Daugherty (2007) and Sacher et al. (2009) also confirmed the Kelley and Sahakyan's results and revealed that people under divided attention condition made significantly lower predictions compared to people under full attention condition. There might be two possible reasons of these contradictory findings. The first possible reason might be that we used a weak manipulation in the divided attention condition so that participants could not realize the attention's role on their memory performance and they did not reflect that to their memory predictions. In other words, the secondary task given in the encoding phase was not enough to distract people's attention.

Another reason for contradictory results with previous experiments might have been the use of different design than previous studies. For instance, in contrast to previous studies, in the present study, we asked participants to make prospective judgments during encoding rather than retrospective judgments during retrieval. While other studies requested participants to make memory judgments after completing the whole study session, in our study, we asked participants to make judgments during the encoding phase. Also, in contrast to previous studies, we asked participants to make judgments for each item in the list one-by-one. In other words, participants made their each judgment on an item-by-item basis. However, except for the study of Sacher et al. (2009), previous studies (Kelley and Sahakyan, 2001; Barnes & Daugherty, 2007) required participants to make global judgments at the end of the encoding phase; thus, participants were asked to evaluate their general memory performance by asking how many words they think to remember in each condition after the study was completed. Sacher et al. (2009) is the only study that asked participants to make item-by-item judgment, but they asked these judgments to be made retrospectively during retrieval rather than the encoding phase. In addition, participants made their prediction only for words that participants could not find the pair of the word. In other words, they specifically interested in the feeling of knowing (FOK), not judgments of learning (JOL).

Thus, the current study differs from previous studies in terms of design. Our study is the first study that investigated attention and list composition effect on metamemory processes by using item-by-item and prospective measuring methods. These design differences might have caused those inconsistent results between the findings of previous studies and the present study. While making judgments about their memory performance, people consider many cues. For instance, they think that how easy to encode the material (Begg, Duft, Lalonde, Melnick, & Sanvito, 1989; Koriat, 2008; Koriat, Bjork, SheVer, & Bar, 2004), how easy to retrieve it (Son & Metcalfe, 2005; Koriat & Ma'ayan, 2005; Benjamin & Bjork, 1996; Benjamin, Bjork, & Schwartz, 1998; Kelley & Lindsay, 1993; Robinson, Johnson, & Herndon, 1997; Zakay & Tuvia, 1998), or whether they are familiar with the material (Metcalfe, Schwartz, & Joaquim, 1993). The type of cues that are used usually depend on the way of measuring memory judgments. For instance, when people are asked to make global and retrospective judgment, they mostly make their judgments based on retrieval fluency. On the other hand, in the item-by-item judgment, they take into consideration whether the words is easy to encode, which is called encoding fluency (Alter & Oppenheimer, 2009). Also, as Schwartz (2004) argued, using different kind of cues may affect whether online difficulties will be used as a cue to guide metamemory. That is, it can be said that because the design has an effect on which cue to use during the judgment period, it also indirectly influence subjective experience of people while making judgments. Thus, because, in the current study, we used different design than previous studies, we might have obtained these inconsistent results.

Another hypothesis is about the effect of list composition on JOL scores. We hypothesized that in the within group condition, the difference between participants' judgment scores from divided attention and full attention levels would be significantly greater than the difference between the scores of participants in the between groups; pure divided attention and pure full attention conditions. In other words, participants experiencing both full and divided attention conditions would give significantly higher JOLs in the full attention condition, compared to participants who experienced only the silent condition, which corresponds to pure full attention condition. Also, participants experiencing both full and divided attention condition would give significantly lower JOLs in the divided attention condition compared to participants who experienced only the divided attention condition. However, the findings did not support the hypothesis and showed no significant difference between judgment scores of within group levels and between groups. These results contradict with Susser, Mulligan, and Besken's findings

(2013). As stated in the introduction chapter, Susser, Mulligan and Besken's study is the only study that investigated the effect of list composition on memory predictions in the literature. In order to investigate the list composition effect on memory judgments, they conducted three experiments by using different encoding manipulations in each experiment and compared within and between groups in terms of memory predictions. The findings of all three experiments revealed that the difference within the mixed condition is significantly higher than the difference among the pure groups. That is, the results showed that people are sensitive to variation within the list. However, the findings of the current study do not show parallel findings with these results. The possible reasons might be that the presentation of the noise was very short. In the mixed attention condition, as stated in the method section, participants were given the secondary task intermittently. In other words, in the mixed attention condition, participants experienced both divided attention and full attention conditions in random order. However, the shift between full and divided attention conditions was very close. This might have caused participants to habituate the situation. In other words, because the sound was presented and ceased for very limited time, participants could not understand the difference between silent and noise conditions. Thus, they might have made their memory predictions based on other characteristics of the test, like the familiarity or the relevance of the words, rather than based on the presence or absence of a secondary task. In conclusion, the short presentation and cessation of the noise might explain the inconsistent and unexpected findings about JOL scores of participants.

4.1.2 Recall Performance

In pure attention conditions, participants' recall scores were defined as the ratio of number of remembered words to total critical words. In the mixed attention score, like in the JOL scores, was separated according to attention level. Thus, it was defined as the ratio number of remembered words to the half of the total critical words.

We hypothesized that participants under divided attention condition, regardless of their list condition, would significantly remember fewer words in the memory test compared to participants under the full attention condition. However, the findings of both experiments did not support our prediction. Previous studies that looked for the relationship between divided attention and memory performance showed that people's memory performance declines when they are performing two tasks concurrently (Neath, Farley, & Surprenant, 2003; Gaspelin, Ruthruff, & Pashler, 2013; Franssen, Vandierendonck, & Hiel, 2006). However, our results contradict with these findings. The reason of this contradictory result might be that the manipulation was not strong enough to induce divided attention effect. In order to distract participants' attention, we just gave them a sound in both experiments and participants did not have to do anything for secondary task, they were just requested to ignore the sound. Also, as stated before, because the shift between sound and no-sound conditions was too short, ignoring the sound might have been easy for participants. In other words, as stated before, they might have been habituated to the sound that were given and cut in very limited time.

As a secondary task, we used the same method with the study of Hygge, Boman, and Enmarker (2003) and gave participants a sound of irrelevant speech, which was played backward in the first experiment, and the recording of heavy traffic sound in the second experiment. In this study, researchers investigated the effect of divided attention on different memory systems, like free recall or recognition of text reading, recognition of words, faces, etc. The results of the study showed that except for recall or recognition from the text reading, other dependent variables were not affected from both noise of irrelevant speech and heavy traffic sound. Thus, this study showed that divided attention decrease memory performance when the material is a reading test rather than a list of word or faces or names to remember. Thus, the reason of that we did not find significant effect of divided attention on memory performance might have caused from using a word list rather than a reading text. While reading a text, we may need more silence to comprehend and relate the information in the text. However, while memorizing the words one-by-one, we do not have to relate the words, we just focus the words respectively.

4.2 Limitations of The Current Study and Suggestions for Future Studies

The hypotheses of the current study were not confirmed for neither Experiment 1 nor Experiment 2. The reason of these insignificant and contradictory results might be a consequence of the limitations of the present study. Now, these limitations will be discussed and suggestions for future studies will be considered.

As stated before, we did not find a significant detrimental effect for divided attention on memory performance, in contrast with previous studies. One possible reason for the failure to replicate the results might the recruitment of a weak divided attention manipulation. We tried to increase the intense of the secondary task by increasing the volume in Experiment 2, but it did not work. Thus, future studies should use more demanding tasks to divide participants' attention rather than a using a passive task. For instance, they may ask participants to repeat a word or a number such as "the" while they are trying to memorize the words as previous divided attention studies did (Alloway, Kerr, & Langheinrich, 2010; Larsen and Baddeley, 2003; Landry & Bartling, 2011; Wickham & Swift, 2006; Franssen, Vandierendonck, & Hiel, 2006; Christoffels, 2006; Liefooghe, Vandierendonck, Muyllaert, Verbruggen, & Vanneste, 2005). In addition to articulatory suppression task, future studies might use other types of demanding task in order to distract participants' attention. For instance, as Benjamin et al. (2000) asked participants to count backward from a random number, which was given via headphones, while they were performing the main task simultaneously. Another secondary task might be to use a more visual task. For instance, future studies might give the words list over headphones and at the same time, participants might be requested to follow the instructions that will be given on the screen. Like in the study of Craik et al. (1996), future studies might instruct participants to follow the asterisk that will appear on the computer screen and press the corresponding button to point out asterisk's place. All of these tasks mentioned above might occupy people more such that they cannot focus on the main task. Thus, people might become more wary of the crucial role of attention on their subsequent memory performance and might reflect that to their memory predictions.

Another possible reason of this null result might be to use word list as a main task rather than passage to read. As stated before, while reading a passage, we need to focus more deeply than while we are studying a single word. Thus, future studies might try to use passages rather than words as a main task. In this experiment, they might follow exactly the same procedure with the current study while distracting participants' attention and assessing their memory judgments. However, they may change the material given in the study phase. For instance, future studies may give participants a number of expository passages about various topics. After each passage is presented one by one, participants may make a prospective memory judgment about their general memory performance for this passage on the subsequent test. Later, they can ask some elaborative questions about each passage in the memory test. In this way, the setting of the experiment will be also more similar to daily settings like education or workplace.

Also, in the present study, in contrast to expectations, we did not find list composition effect for memory predicitons. This might have been caused by the limited presentation of the distracting sound in the mixed attention condition. In other words, as stated in previous section, because the shift between full and divided attention conditions was very close, participants might have habituated the situation, so they were not affected from the variation within the list. In order to get rid of this limitation, future studies might replicate this study by presenting the distracting sound for a longer time. In this way, when the sound is ceased, people can understand more clearly the value of attention on their memory, and reflect this to their predictions by giving lower scores in sound condition than in silent condition.

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