AGE RELATED CHANGES IN RECOGNITION MEMORY FOR EMOTIONAL STIMULI

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ABSTRACT

AGE RELATED CHANGES IN RECOGNITION MEMORY
FOR EMOTIONAL STIMULI

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Recognition memory - a type of episodic memory in long term memory - is known in the literature to be affected by emotion, aging and the modality of the presented stimuli. The major aim of this study was to investigate whether emotional stimuli enhances recognition memory. Another goal was to observe whether modality and aging effects are present and differentiable in a non-Western subject sample. In literature, emotion studies were based on mainly two dimensions of emotions: valence and arousal. However, the contribution of these two dimensions to the enhancement of recognition memory still needs clarification. The present study investigated specifically the effect of valence on recognition memory. Moreover, the experimental manipulations of this study allowed observing the effect of valence on recognition memory due to normal aging. Since modality of the presented stimuli is a major confounding factor on recognition, separate experiments involving visual and verbal stimuli

were designed. Pictures and words were selected on the basis of valence and arousal ratings. The stimulus set of the visual recognition memory task consisted of the pictures selected from the International Affective Picture System (IAPS) (Lang et al., 2005). The stimulus set of the verbal recognition memory task was constructed from partially standardized material for affective norms of Turkish emotional words (METU TEW), which was developed as a part of this study. METU TEW allowed selecting words with positive, neutral and negative valence while controlling arousal. The results replicated two findings reported in the literature: (1) younger adults recognized more accurately than older adults; (2) recognition memory was enhanced for visual items regardless of age and valence. Interestingly, this study revealed that recognition memory was not enhanced for emotional stimuli varying only on the valence dimension. More specifically, there was a decline in recognition memory for positive items and no change was observed for negative items, regardless of age. Further analysis also revealed that there may be differential effects of abstractness and concreteness on verbal recognition memory in aging.

Keywords: Recognition Memory, Emotion, Valence, Aging

ÖZ

DUYGU İÇEREN UYARANLAR İÇİN TANIMA BELLEĞİNDEKİ YAŞA BAĞLI DEĞİŞİKLİKLER

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Uzun süreli bellekteki olaysal belleğin bir çeşidi olan tanıma belleğinin duygulardan, yaşlanmadan, ve uyaranların modalitesinden etkilendiği bilinmektedir. Bu araştırmanın öncelikli amacı tanıma belleğinin duygusal uyaranlar karşısında daha iyi işlediği savının sınanmasıydı. Diğer bir amacı da yaş ve modalitenin, batılı olmayan bir denek örneklemi üzerindeki etkilerini gözlemlemekti. Literatürdeki duygu araştırmalarının temel olarak iki boyuta dayandırıldığı görülmektedir: değerlik ve uyarılma. Ancak, bu iki boyutun tanıma belleğine katkılarının halen netleştirilmesi gerekmektedir. Bu araştırma, tek başına değerlik boyutunun tanıma belleği üzerindeki etkisini incelemiştir. Ayrıca, bu araştırma kapsamındaki deneysel etkilemeler, değerlik boyutunun tanıma belleği üzerindeki etkisinin normal yaşlanma ile değişiminin de incelenmesini sağlamıştır. Uyaran modalitesinin tanıma açısından ciddi bir kirletici etken arz ettiği göz önüne alınarak, görsel ve sözel uyaranlar içeren iki

ayrı deney hazırlanmıştır. Değerlik ve uyarılma derecelendirmelerine dayalı olarak sözler ve resimler seçilmiştir. Görsel tanıma belleği deneyinin uyaran grubu Uluslararası Duygusal Resim Sistemi'nden (IAPS) (Lang ve diğerleri, 2005) seçilen resimlerle oluşturulmuştur. Sözel tanıma belleği deneyinin uyaran grubu ise, bu araştırmanın bir parçası olarak, Türkçe sözcüklerin duygusal yüklerinin kısmen standartlaştırılarak belirlenmesi (METU TEW) neticesinde oluşturulmuştur. METU TEW sayesinde, uyarılma sabit tutularak, olumlu, nötr ve olumsuz değerlik taşıyan sözcükler seçilmiştir. Sonuçlar, literatürde vurgulanan iki bulguyu yansıtmıştır: (1) genç erişkinlerin tanıma performansı yaşlı erişkinlerinkine kıyasla daha iyidir; (2) tanıma belleğinin, yaş ve değerlikten bağımsız olarak, görsel uyaranlar için daha başarılı olduğu görülmüştür. İlginç bir şekilde, değerlik boyutunda değişkenlik gösteren duygusal uyaranların tanıma belleğine katkısı olmadığı görülmüştür. Şöyle ki, yaştan bağımsız olarak, olumlu uyaranlar karşısında bir düşüş görülürken, olumsuz uyaranlar için bir değişiklik gözlenmemiştir. Sözel tanıma belleğinin daha detaylı incelenmesi sonucunda, duygunun soyut sözcükler üzerindeki etkisinin araştırmaya değer olduğu kanısına varılmıştır.

Anahtar sözcükler: Tanıma belleği, Duygu, Değerlik, Yaşlanma

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CHAPTER 1

INTRODUCTION

Human memory is a realm attracting much interest in the field of cognitive science, as it forms the basis of knowledge and abilities. Without investigating how information is gathered, processed and reconstructed, it would be difficult to understand cognitive processes in general.

In order to understand how the human memory works, various paradigms and models were introduced, especially after the cognitive era, based on duration, nature, encoding and retrieval of information. Regarding duration, human memory can be classified as long term memory and short term memory. Long term memory is further divided into explicit and implicit memory with respect to retrieval of information. Implicit memory refers to remembering information without being aware of it, whereas explicit memory refers to conscious retrieval of information. Explicit memory branches further into episodic and semantic memory.

The term episodic memory was first introduced by Tulving (1983), referring to a system of memory that renders possible the conscious recollection of (personal) happenings and events from one's personal past and the mental projection of anticipated events into one's subjective future. Mainly two kinds of tasks are used to measure episodic memory performance: recall and recognition. In recall tasks, participants are given a list of items to study first. After this study period, they are required to recall these items. In recognition

tasks, participants are again given a list of items to study, but this time in the test period, they are required to recognize the previously studied items from a list which also contains new items. It is claimed that in these kinds of tasks, people use two processes: recollection and familiarity. In recollection, participants consciously remember having studied the item in a manner that they can recollect, in detail, when and where they saw the item. In familiarity, however, participants cannot remember having studied the item, but rather they feel familiar to the item. In other words, participants are sure that they saw the item without recollecting the item in detail. Therefore, recall and recognition tasks account for different processes of episodic memory, and so episodic memory can be further divided into recall memory and recognition memory.

On another front, research on recognition memory (e.g., Ocshner 2000; Sharot, Delgado & Phelps, 2002; Kensinger & Corkin, 2003) suggests enhanced recognition of events and items containing emotional information. This enhancement is claimed to stem from the recollection process rather than the familiarity process. On the other hand, the failure of some research (e.g., Maratos, Allan & Rugg, 2000; Dougal & Rotello, in press) to find this effect suggests that the recognition memory literature bares some inconsistencies regarding the effect of emotion.

Yet another intriguing issue in the memory literature is age related changes. Grady (2000), Grady & Craik (2000), Kensinger (2005) point out that memory deteriorates due to normal aging. In order to develop a full understanding of the working principles of human memory, it is important to observe which processes of memory decline due to normal aging. Therefore, changes through the life span in memory will guide researchers for more accurate models of human memory. Some research (e.g., Parks, Toth, & Smith, 2004, cited in Howard et al. 2006) found that normal aging was associated with a decline in recognition memory due to a decline in both of the responsible processes; recollection and familiarity. On the contrary, other studies (e.g., Howard, Bessette-Symons, Zhang & Hoyer, 2006) found that reductions in recognition

memory due to normal aging were specific to recollection process. There is also a growing literature on recognition memory (e.g., Charles, Mather, and Carstensen, 2003; Thomas, 2006) suggesting that older adults are more sensitive to emotionally positive events. Similarly, older adults are claimed to improve emotion regulation[1] such as maintenance of positive affect and decrease of negative affect.

The motivation of this study stems from the discrepencies in the literature regarding effects of emotion on recognition memory in young and aging populations. Interestingly, despite the overall decline in memory, emotional processing remains intact with aging. As a result, this thesis is designed to focus specifically on the effects of emotion and aging on recognition memory.

It has long been accepted that emotions have three orthogonal dimensions: valence, arousal, dominance. Valence is the dimension ranging from pleasant to unpleasant (e.g., "fear" has unpleasant connotations whereas "confidence" has pleasant connotations). Arousal is the dimension referring to the intensity or impact of emotional experience (e.g., "fear" is an arousing emotion whereas "confidence" does not imply a great deal of arousal). Dominance, a less strongly-related dimension, ranges from feelings of strong to weak (e.g., "fear" involves a feeling of weakness whereas "confidence" involves a feeling of strength) (Bradley and Lang, 1999). In order to investigate the emotion effect on recognition memory, the stimulus set was constructed based on ratings of two dimensions of emotion; valence and arousal[2]. Earlier studies on emotional effects did not differentiate between the arousal and valence dimensions systematically. In our study, we focused only on the valence dimension, while setting the arousal dimension to neutral values.

[1] Emotion regulation refers to the processes by which individuals influence which emotions they have, when they have them, and how they experience and express these emotions (Gross, 1998).

[2] Previous research on emotion and memory considered valence and arousal as the main dimensions of emotions.

Previous research on recognition memory revealed modality effects, such that pictures are recognized better than words. Therefore, the present study was designed to observe age related changes in recognition memory using both verbal and visual stimuli. The visual stimulus set was constructed from the widely used International Affective Picture System (IAPS) (Lang, Bradley and Cuthbert, 2005) which provides a set of normative emotional stimuli rated for the three dimensions of emotion. Due to lack of a set of normative emotional stimuli for Turkish words, a normative study, named METU Turkish Emotional Words (METU – TEW) was initiated and was used in the verbal recognition memory task. As a part of this normative study, a set of Turkish words was rated for valence, arousal and dominance by 50 participants with varying ages. From the results of this norming study, a subset of the emotionally normative words was chosen to constitute the verbal stimulus set. Both visual and verbal stimulus sets were carefully arranged to consist of emotional items with negative, neutral and positive valence but neutral arousal.

The major goal of this research was to measure the overall recognition performance for emotional stimuli, while also investigating the contributions of familiarity and recollection. Considering the literature on age effects, it was hypothesised that older adults would not perform as good as younger adults in recognition memory tasks. According to another hypothesis, a modality effect would be observed, such that, pictures will be recognized more accurately than words. Our last hypothesis rests on the evidence that emotion enhances recognition memory. Unfortunately, early research on this issue has not identified contributions of valence versus arousal in this enhancement. Therefore, we will investigate specifically how valence affects recognition memory in young and aging groups.

The organization of this thesis is as follows. In Chapter 2, the literature on recognition memory, interaction between emotion and memory and age related changes in memory and emotion processing is presented in detail. In Chapter 3, the methods and results of the normative study on Turkish emotional words

will be given in addition to the methods and results of the recognition memory experiments. In Chapter 4, the results will be discussed with possible explanations in the light of the previous research, as well as limitations. Finally, Chapter 5 draws a brief conclusion of the study.

CHAPTER 2

LITERATURE REVIEW

This chapter reviews the literature under three main topics: recognition memory, interactions of emotion and memory, and finally, age related changes in memory. Firstly recognition memory will be reviewed with respect to both theory and measurement methods of recognition memory. Then the influence of emotion on memory will be reviewed with respect to both psychological and neuropsychological evidences. Finally, the literature of aging effect on memory and emotion will be summarized.

2.1 RECOGNITION MEMORY

Tulving (1983) argued that there are multiple memory systems. For the long term memory, there are two main distinctions; non declarative (implicit) and declarative (explicit) memory (see Figure 1). Declarative memory also divides further into two systems which are episodic and semantic memory. Episodic memory refers to events that occupy a particular spatial and temporal context, and semantic memory refers to general knowledge about the world (Squire, Knowlton & Musen, 1993).

Recognition memory is a type of episodic memory, which enables us to distinguish previously learned items from new items. In recognition tasks participants are given a list of stimuli in the study session and after a retention interval participants are given another list of stimuli which contains both

studied items and new items. Then participants are then required to identify the items that they have seen previously from the new items.

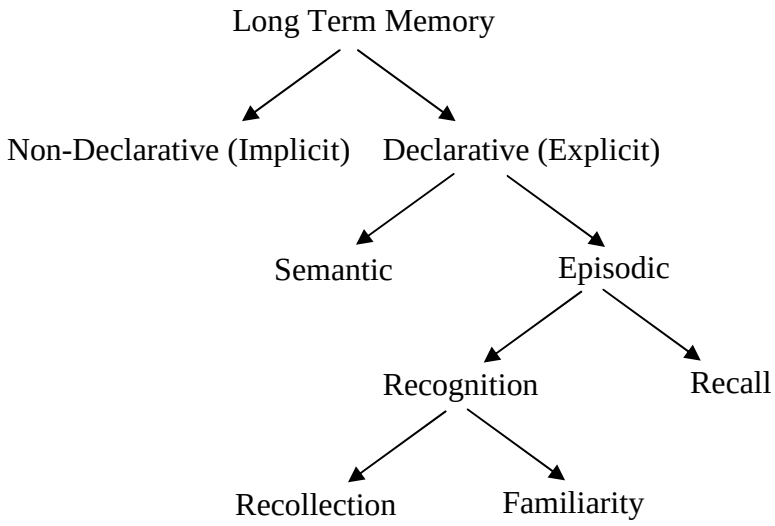


Figure 1 Taxonomy of Memory

There are mainly two views of recognition memory: Dual-process theory and signal detection theory. **Dual-process theory** states that recognition decisions are based on two distinct memory processes called recollection and familiarity (Atkinson & Juola, 1974; Jacoby, 1991; Tulving, 1983; Mandler, 1980; Yonelinas, 1997). Recollection is a relatively slow and effortful process whereas familiarity is an automatic and fast process. Recollection consists of retrieving details associated with the previous presentation of the item; on the other hand familiarity helps us to know the item without recollecting contextual details. Recognising a person can be a good illustration for these processes. Sometimes when we recognize a person we cannot remember from where we know this person, we cannot explicitly remember having met that person. In these kinds of situations, only the familiarity process is active. On the other hand, if we can remember how we met that person, the recollection process is active.

Signal-detection theory which was introduced to psychology by Green and Swets (1966), states that recognition decisions are based on the strength of a memory signal in relation to a decision criterion (Wixted, 2007). This view suggests that there is a single process underlying the recognition memory. This theory involves two equal variance Gaussian distributions; one representing old items (targets) and one representing new items (lures), and one decision criterion. If the signal strength of the test item is above the decision criterion then the item is affirmed to be 'old', and if the signal strength is below the decision criterion then it is declared to be 'new' (see Figure 2).

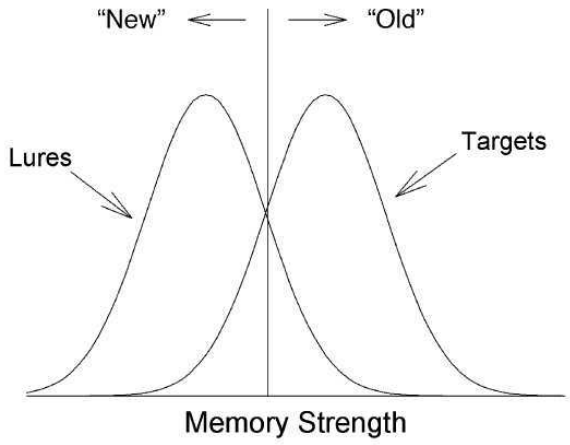


Figure 2 Equal variance signal detection model (Wixted & Stretch, 2004)

Another view is proposed by Yonelinas (1994), which reconciles the two main views of recognition memory. **Yonelinas High Threshold/Signal Detection Theory (YHT)** suggests that recollection is a high threshold process[3] that may or may not occur, and that familiarity is an equal variance detection model[4]. Familiarity-based decisions are made when the recollection process fails. In

[3] The original high-threshold model held that recognition is a probabilistic process, in which, a test item is either recognized (i.e., it falls above a threshold) or it is not (i.e., it falls below threshold), with no degrees of recognition occurring between these extremes (Wixted, 2007).

[4] Equal varience detection model states that familiarity is a continuous variable, and because targets and lures have some degree of familiarity associated with them, these decisions are thought to be characterized by the signal-detection process (Wixted 2007).

other words, when a target item is presented and the participant cannot recollect the item, the decision is made by use of the familiarity component. Familiarity decisions are thought to be based on signal detection theory, because familiarity is considered to be a continuous variable.

2.1.1 From Dual Process Models to Yonelinas High Threshold Model

The dual process models of recognition memory are divided into several groups with respect to different aspects of recognition memory. Firstly, from a general organization of memory perspective, Tulving's model will be discussed with supporting evidence from neuroanatomical data. Then, two more models will be discussed in order to emphasize the discrimination between the two processes (recollection and familiarity). These two models, the Jacoby model and the Yonelinas model, which differentiates two systems by distinguishing the type of information they provide.

According to Tulving, recognition performance is considered to be based on both episodic and semantic memory. The episodic memory system gives rise to conscious remembering, whereas the semantic memory gives rise to conscious knowing of the item. At the time of encoding, information passes through the semantic system to the episodic system. However, at the time of retrieval, the two systems are independent and can operate in parallel. Tulving also supports this idea by indicating that there are distinct brain regions for semantic and episodic memory. For instance, the hippocampus is important for episodic memory, and surrounding structures of the medial temporal lobe are critical for semantic memory.

Some neuroanatomical data (Eichenbaum, Otto & Cohen, 1993) supports Tulving by proposing that the hippocampus is critical for recollection with a distributed pattern, and the surrounding structures of medial temporal lobe are critical for familiarity. From neurological studies, it is observed that patients with more extended damage to the medial temporal lobe show deficits in both familiarity and recollection. However, patients with hippocampal damage show

deficits in recollection only. In addition to the role of medial temporal lobe, frontal regions are also found to be related with memory functions, such that right prefrontal regions are critical for retrieval from episodic memory, and left prefrontal regions are critical for retrieval from semantic memory and encoding into episodic memory. This is also known as Hemispheric Encoding and Retrieval Asymmetry (HERA) (Nyberg, Cabeza and Tulving, 1998). HERA can also be considered as an evidence for the involvement of both semantic and episodic memory in recognition.

From another perspective, Jacoby and colleagues (1983, 1984, 1991, cited in Yonelinas, 2002) suggest that recognition memory judgments are based on processing fluency and elaboration given to the item. Thus, recollection is deemed to be an analytic and consciously controlled process, whereas familiarity is deemed to be an automatic process. Thus, "[familiarity] arises when fluent processing of an item is attributed to past experience with that item" (Yonelinas, 2002, p.445).

Yonelinas and colleagues distinguish recollection and familiarity "in terms of the type of information that they provide and in the extent to which each process influences recognition confidence" (Yonelinas, 2002, p. 446). Familiarity is said to reflect the "quantitative" memory strength information, which is described by Signal Detection Theory. Recollection, on the other hand, reflects "qualitative" information about the previous event retrieved. When qualitative information such as where, what, when cannot be retrieved by the subject, the subject relies on familiarity. Recollection decisions are based on a high threshold process that determines whether the subject recollects or not, and familiarity decisions are based on a continuous range of recognition confidence. This model, just like most of the models, assumes that recollection and familiarity operate in a parallel and independent fashion. The two processes are considered to be independent and the type of information that familiarity and recollection provide is regarded as the main difference that

distinguishes the two processes. In order to measure the performance on recognition memory several methods are introduced by researchers.

2.1.2 Measurement Methods of Recognition Memory

Several measurement methods are suggested in the literature to quantify recognition memory due to different models. As mentioned previously, there are basically two models; dual process and signal detection. Measurement methods used within each model are summarized below with emphasis on the ones used in this study.

2.1.2.1 Dual process models

In order to evaluate the dual process models of recognition memory mentioned above, many measurement methods were developed with certain assumptions. These methods fall into two general categories of *task-dissociation methods* and *process-estimation methods* (Yonelinas, 2002). In general, task dissociation methods identify a task or test condition that isolates one of the processes. For example, response-speed methods are a subcategory of task-dissociation methods which rely on the assumption that familiarity is faster than recollection. Thus, recognition performance is examined for fast and slow responses in a regular recognition task. The fast responses are considered to reflect the familiarity process and slow responses are considered to reflect the recollection process. Another task-dissociation method can involve making inferences by comparing recall tasks and recognition tasks. The recollection in a recall task is assumed to be similar to the recollection in recognition task. Thus, if a variable has a larger effect in a recall task than in a recognition task, then that variable is said to have an effect on the recollection, not familiarity. However, these methods have disadvantages because the patterns of the results may be problematic. For example, the differences of the performances on recall and recognition task may not be on the same scale, so it would be misleading to compare the results as if the performances were on the same scale. In order to overcome this problem, some quantitative methods were developed which form the second category mentioned above: process-estimation methods.

Process-estimation methods are further divided into three subcategories; namely process-dissociation procedure; and Receiver Operating Characteristic (ROC) procedure; remember/know procedure (Yonelinas, 2002). Process-dissociation procedure, first used by Jacoby (1991), measured the ability to remember when or where an item was studied earlier. For example, participants studied both a visual and audio list, then they were first instructed to respond “yes” if they have studied the item before regardless of the list type, and then in another test condition they were instructed to respond “yes” to heard or seen list items. In the first test condition, the responses were made based on both recollection and familiarity. In the second test condition, however, the decisions were made only based on recollection. Thus, the “yes” responses in both test conditions can be used for estimating the recollection and familiarity indices. It is also possible to estimate the contribution of recollection and familiarity by using the Receiver Operating Characteristic (ROC) procedure. The ROC procedure is actually used in signal detection models, which will be discussed in detail. According to the High Threshold / Signal Detection Theory, the familiarity process behaves like a signal detection process, so in order to measure familiarity; the ROC procedure can also be used. In the ROC analysis, an equation is derived that describes how hit rates (old responses given to studied items) and false alarm rates (old responses given to non-studied items) should be related when performance reflects a combination of recollection and familiarity (Yonelinas 2002). Then this equation is fit to the observed empirical ROC which is derived by subjective confidence ratings of each participant.

In this study, among these quantitative measures, the 'remember/know' paradigm was chosen to study the states of awareness accompanying recognition memory. The ‘remember/know’ paradigm was first introduced by Tulving (1985) in order to study the nature of conscious experience in explicit memory tests such as recognition memory tasks. The remember/know paradigm measures the contributions of the recollection and familiarity processes in the overall system by requiring subjects to introspect about their

judgments. Subjects are required to respond "remember" if they can remember explicitly and vividly studying the item (i.e. "I can remember studying the word in the list"). Subjects are required to respond "know" if they cannot remember explicitly and vividly studying the item but they are sure that the item was on the list. Remember responses are used to estimate the contribution of the recollection process and know responses are used to estimate the contribution of the familiarity process.

Researchers (Tulving, 1985; Gardiner, 1988; Gardiner and Parkin, 1990) found different effects on 'remember' and 'know' judgements in several studies. For example, Tulving (1985) reported that as the retention interval increases (from day 1 to day 8) 'remember' responses decline relative to overall recognition. Gardiner (1988) also observed a levels-of-processing effect[5] for 'remember' responses, such that there is superior recognition for memory items studied under semantic associates than items studied under perceptual associates. In another study, Gardiner and Parkin (1990) examined the effects of divided attention[6] on 'remember' and 'know' responses. 'Remember' responses were reported to be affected from the divided attention study condition but 'know' responses were equivalent for both undivided and divided study conditions. In summary, these experiments show that remember and know responses are based on functionally different processes.

It has been further suggested by Yonelinas and Jacoby (1995) that the recollection and familiarity processes can be quantitatively estimated from the measures of 'remember' and 'know' responses. The proportion of 'remember' responses should provide a measure for recollection. 'Know' responses, on the other hand, are ambiguous. Subjects respond 'know' when they feel familiar and cannot recollect and hence, 'know' responses reflect familiarity in the absence of recollection. According to Yonelinas and Jacoby (1995) these two

[5] Craik and Lockhart (1972) found that the durability and strength of memory traces depends on depth of processing (i.e., the deeper the level of processing the longer and stronger the memory trace).
[6] Subjects engage in a secondary task in addition to main task at a test.

processes can occur independently. Thus, they introduced the independency to this paradigm by correcting with the familiarity estimate. For the recollection index probability of a remember response is used. On the other hand, ‘know’ responses were given when an item is familiar and not recollected. Thus ‘know’ responses can be represented as

$$K = F(1-R) \quad (1)$$

where *K* denotes the probability of ‘know’ responses, *F* is the familiarity index and *R* is the probability of ‘remember’ responses.

Without correction, the proportion of ‘know’ responses will underestimate the probability that an item is familiar. To correct the familiarity estimate, then ‘know’ responses are divided by the opportunity to give ‘know’ responses. Thus, the index of familiarity is calculated by rearranging Formula 1 as shown below.

$$F = \frac{K}{(1-R)} \quad (2)$$

where, as before, *F* is familiarity index, K denotes the probability of ‘know’ responses and R represents the probability of ‘remember’ responses.

With these corrections, the remember/know paradigm becomes consistent with the independence assumption of the Yonelinas model. In this study, the corrected version of remember/know paradigm was used in order to distinguish familiarity and recollection processes

2.1.2.2 Signal detection model

In order to evaluate the signal detection theory of recognition memory, more general methods such as old/new recognition memory are used. As described

previously, old/new decisions are thought to be made on the basis of signal detection theory which states that recognition memory processes rely on a single process. If the test item generates a memory signal that exceeds the decision criterion then it is declared to be old; otherwise it is declared to be new (Wixted, 2004). Thus, according to Wixted (2004) this theory assumes that recognition decisions are based on variable strength-of-memory traces. A detailed analysis on recognition memory is also possible using the ROC procedure. In addition to requiring participants to respond "old" or "new", the ROC procedure requires their subjective rating of confidence level for giving that response. Thus, the behaviour of hit rates and false alarm rates are observed for different confidence levels.

Although Rajaram (1993) had shown that remember/know judgements showed different behaviour than sure/unsure judgements, a debate was initiated by Donaldson (1996) who argued that remember and know judgements might reflect different memory strengths. Thus these judgments can be adapted to fit signal detection theory. More specifically, Donaldson (1996) states that 'remember' and 'know' decisions are made based on two different decision criteria. The 'know' criterion is situated at a relatively lower point when compared to the 'remember' criterion. (Figure 3) According to this argument, if the memory signal that the item generates is above the 'remember' criterion the response is 'remember' and if the memory signal is between the 'know' criterion and the remember criterion then the response is 'know'. Thus, according to this argument, remember/know judgments do not have to reflect qualitatively two different memory processes rather these judgments can reflect different decision criterions in a signal detection theory of recognition memory.

Wixted & Stretch (2004) argued further that there should be a relationship between 'remember/know' judgments and confidence ratings. In a study by Stretch & Wixted (1998), subjects were asked to classify their old judgments as 'remember' or 'know' and they were also asked to rate their recognition decisions in terms of a degree of confidence. In addition to hit rates, they

observed the false alarm rates of ‘remember’ and ‘know’ judgements. They showed that ‘remember’ false alarms were made with higher confidence and more quickly than know hits. What they also found was that confidence ROCs predicted ‘remember/know’ ROCs. Hence, they concluded that ‘remember/know’ judgments may represent different decision criterions based on confidence in judging the item as ‘old’ or ‘new’. In the methods section, how both dual – process and signal detection theories was utilized in this thesis will be described in further detail.

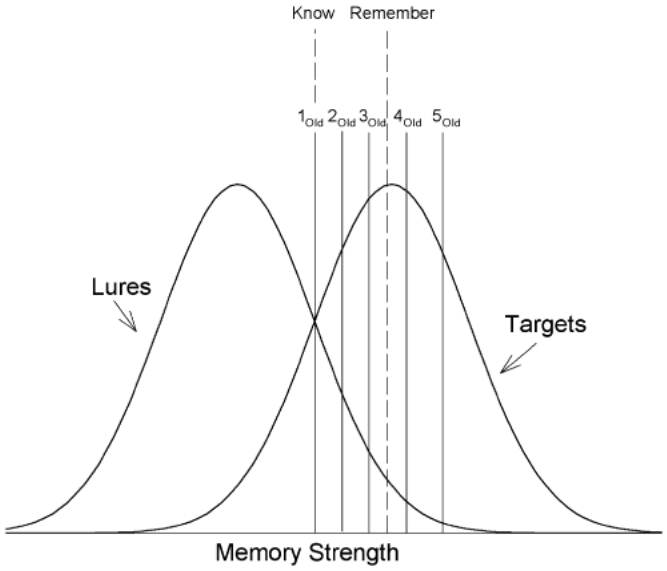


Figure 3 Signal detection interpretation of ‘remember/ know’ judgements (Wixted, 2004)

2.2 EMOTION AND MEMORY

It has been known that emotionally salient events enhance episodic memory causing these events to be recollected more vividly and clearly, when compared to neutral events. Research on cognitive neuroscience of emotion and memory has specified mainly two structures; the hippocampus for encoding episodic memory and the amygdala for modulating episodic memory. These two systems are found to have influences on each other. More specifically, the amygdala modulates the hippocampus by influencing encoding, consolidation and retrieval.

2.2.1 Neural bases of two different systems - emotion and memory

Evidence suggests that subcortical circuits which involve telencephalic structures (basal ganglia, limbic circuits, and cortex), diencephalic structures (thalamus and hypothalamus) and mesencephalic structures (pontine reticular nuclei) are essential to the cortical representation of emotional experience and behavior (Tucker, Derryberry & Luu, 2000). There are two main subcortical circuits; the dorsal corticolimbic pathway and the ventral corticolimbic pathway, which connect neocortex and limbic structures. According to Pandya, Seltzer and Barbas (1988) (cited in Tucker et al., 2000) the mammalian neocortex evolved from limbic structures at two different points. The dorsal corticolimbic pathway which connects the cingulate gyrus, the parietal lobe and the dorsal frontal lobe to the limbic system is thought to have emerged from the hippocampus and the ventral corticolimbic pathway, which connects the inferior temporal lobe and the orbitofrontal lobe to the limbic system is thought to have emerged from the primitive olfactory cortex. In addition to this, the architecture of the telencephalon shows that the limbic structures connect the sensory representational networks of the posterior brain to the action representational networks of the anterior brain. Thus, subcortical limbic structures such as the thalamus funnel the widespread cortical sensory inputs to key regulatory systems to modulate the arousal and motivational state of the neuroaxis[7] (Tucker, Derryberry and Luu, 2000).

Based on the anatomical distinction of the dorsal and ventral pathways, Tucker et al. (2002) claimed that those dorsal and ventral pathways may operate under different memory systems. Supporting this claim, two memory circuits have been outlined. One is the ventral circuit which consists of the thalamus, the amygdala, and the ventromedial frontal cortex. The other is the dorsal circuit which consists of the thalamus, the hippocampus and the mediodorsal prefrontal lobe (cingulate). As Phelps (2004) pointed out, the amygdala is more or less specialized for emotional processing, and this ventral circuit of memory

[7] Neuroaxis is an imaginary line through the spinal cord to the front of the brain

is crucial for the acquisition and expression of fear conditioning,[8] which is indispensable for survival. The dorsal circuit that involves the hippocampus is necessary for declarative or episodic memory. Moreover, Nadel (1992) suggested that the hippocampus and dorsal circuit may be important not only for spatial memory but also for contextual memory. This suggestion may also support the view that hippocampal memory formation is crucial for consolidation of episodic memory. On the other hand, as Nadel (1992) believes, the contribution of the ventral memory circuit, which involves the amygdala may be generalized to memory for objects. The object reservoir probably works in connection to the what pathway in vision, and inferior pathway in semantic processing of language.

Although many researchers put forward theories regarding these 'dorsal' and 'ventral' memory systems, there exist considerable inconsistencies regarding the anatomical structures that participate in these two pathways as well as their functional role in memory processes.

2.2.1.1 Influence of emotion on memory

According to Hamann (2001), four key concepts on emotional explicit memory have emerged from animal studies, which are also supported by studies on humans. Firstly, the amygdala is the primary orchestrator of processes of emotional memory. Without the amygdala, the emotional effects are less likely to occur. Secondly, the amygdala can affect explicit memory by modulating the brain regions involved in memory. Thirdly, the release of stress-hormones interacts with the amygdala, affecting the explicit memory. Finally, the modulatory effect of emotionally arousing events through the amygdala acts specifically on the hippocampus.

The amygdala is thought to affect the hippocampus through encoding, consolidation and retrieval (Hamann, 2001; Phelps, 2006, LaBar & Cabeza,

[8] Neutral stimulus acquires aversive properties by being paired with an aversive event.

2006). According to Cahill & McGaugh (1998), since the amygdala is a heterogeneous collection of distinct nuclei, and since these distinct nuclei have different functions in learning, the basolateral AC (amygdoloid nuclei) nucleus is responsible for the modulation of memory storage (consolidation). Thus, there should be a modulation of memory storage for emotional memories. According to some studies, stress-hormones, such as adrenaline, could be considered as a candidate. When emotional stimuli are presented, the stress-hormone system is activated, affecting memory. In this section, the influence of emotion on memory is reviewed for three processes involving memory: encoding, consolidation, retrieval.

Encoding

Hamann (2001) reported several neuroimaging studies that support the role of the amygdala in emotional memory encoding. In these studies, the activation in the right amygdala when the negative and positive stimuli are presented is correlated with higher performance in emotional stimuli in the subsequent memory tests. Hamann (2001) also supported the view that amygdala can modulate hippocampus by showing correlated hippocampal activity with the activity in the amygdala.

According to Phelps (2004), the amygdala can influence hippocampal memory by facilitation of attention with emotion. For enhanced encoding of memory, enhancing attention is one of the most important out of several factors. As neurological evidence suggest, amygdala has reciprocal connections with sensory cortical regions, which facilitates responding to an emotional stimulus rapidly, irrespective of attentional focus. As Phelps suggested, the amygdala might receive emotional information of a stimulus in early processing, and by the help of the feedback mechanisms in the limbic system, it enhances perception and attention, resulting in facilitation of attention with emotion.

LaBar and Cabeza (2006) also report that one additional consequence of emotional arousal is focusing attention on central gist information by

neglecting the peripheral details for complex events. Attentional focusing ensures that emotionally salient features of complex events are preferentially retained in memory. They also support this view by showing that patients with amygdala lesions fail to focus on central gist information in memory tests.

Consolidation

Phelps (2004) claimed that events that elicit emotional responses are likely to be more important for survival, thus likely to be remembered more. According to her, evidence from animal models suggests that the amygdala modulates the consolidation of episodic memory by influencing the hippocampus through stress hormones such as adrenaline. According to Labar and Cabeza (2006), emotional situations activate complex interactions between adrenergic and glucocorticoid systems, resulting in adrenaline releases.

Hamann (2001) supports the role of the amygdala in memory consolidation by reporting that individuals with amygdala damage appear to be impaired significantly in mechanisms that enhance explicit emotional memory, but show normal reactivity to emotional stimuli. More specifically, as Phelps (2004) reviewed, Dolan et al. (2004) had studied patients with varying degrees of pathology to the hippocampus and the amygdala during the encoding of emotional and neutral words. They found that the left amygdala pathology was correlated with the subsequent memory for emotional words, in that the higher the left amygdala pathology, the worse was the performance on emotional memory. On the other hand, memory for neutral words was only related to the degree of hippocampal damage. Thus, the findings of Canli et al. (2000) and Hamann (2001) suggest that encoding and consolidation mechanisms interact in a way that emotionally arousing events and stimuli are processed differently during encoding, resulting in an enhanced long-term consolidation.

Tucker et al. (2000) suggest that there is a hierarchical anatomy of emotion and memory. Nucleus basalis is a modulator for interactions between the cortex and the limbic system, which is important for gating cortical information into and

out of the limbic system. The sensory inputs are first projected to the limbic system, then to the nucleus basalis. Later, the nucleus basalis projects the feedback to modulate the corticolimbic traffic. After the emotional content of cortical input is determined by the limbic system, the nucleus basalis motivates memory consolidation.

Retrieval

Hamann (2001) reviewed two studies that examined the role of the amygdala in emotional episodic memory retrieval. In the first one, the retrieval of personal autobiographical memories was studied, and increased activity in the right prefrontal cortex, the right amygdala, the right hippocampus, the temporal pole and the insula were found to be associated with retrieval of personal autobiographical memories with emotional salience. In the second one, which was an experimenter created emotional memory study, Dolan (2000, cited in Hamann, 2001) examined retrieval using factorial design that varied stimulus valence (negative, neutral, positive), retrieval (incidental, intentional) and retrieval success. The results show that the temporal pole was related with emotional memory retrieval, yet the left amygdala was activated only during successful intentional retrieval of emotional items, which is the actual retrieval of emotional memories. Thus, these results support the idea that the amygdala has a modulatory role in the retrieval of memories, as well as a role in encoding and consolidation, and probably there is hemispheric asymmetry in the distribution of these roles.

2.2.1.2 Influence of memory on emotion

Memory and emotion influence each other bidirectionally. As this thesis investigates the effect of emotion on memory, the influence of memory on emotion will not be reviewed in detail. Only the fear condition paradigm will be given as an evidence of the influence of memory on emotion.

The fear conditioning paradigm, an example of non-declarative memory (LaBar & Cabeza, 2006), can be considered as an evidence of how

hippocampal memory can influence the amygdala. In fear conditioning studies, when a neutral stimulus (blue box) is presented with an aversive event (mild shocks to the wrist), participants show an arousal response during presentation of the blue box even when there is no mild shock. Similarly, human beings are known to be the only animals that experience amygdala activation through instructed but not experienced fear. Thus, according to Phelps (2004) having an instructed episodic representation of the emotional significance of a stimulus can lead to activation in the amygdala, which in turn mediates the physiological expression of fear when this stimulus is presented.

2.2.2 Experimental Evidence of Interactions between Emotion and Memory

There are several experimental studies that support the idea of vivid memories for emotionally arousing events. Ochsner (2000) conducted a set of experiments in order to observe whether emotional events are richly recollected when compared to neutral events. Two factors that ensure better recollection were found to be distinctiveness and attentional salience. An increase in the distinctiveness of an item will imply that the item is more likely to be recollected. In addition, more attention on encoding the item will result in a clearer recollection of the item. This is due to the fact that: (1) emotional stimuli are elaborated differently from neutral stimuli (Cato, Crosson & Gökçay, 2004) and (2) emotional stimuli capture more attention than neutral stimuli. When it comes to familiarity, Ochsner suggests that emotional stimuli are processed more fluently than neutral stimuli, because familiarity depends on the ease of the processing of the item. He used pictures that have different levels of emotional valence and arousal for study and recognition. At the recognition stage, he used the 'Remember/Know' procedure. Then he manipulated the attention of subjects to the positive, negative and neutral pictures by making the subjects evaluate the picture either conceptually (e.g. "Do you want to get closer to the picture?") or perceptually (e.g. "How bright is the picture?"). After a one-week retention interval, participants took part in an incidental recognition memory experiment. Finally, he concluded that,

although the overall recognition does not change significantly between emotional valence conditions, negative stimuli tended to be ‘remembered’ and positive stimuli tended to be ‘known’. He also found that recollection, which was estimated from ‘remember’ responses, was enhanced for negative valence and highly arousing stimuli, and to a lesser extent, for positive stimuli. Finally, these patterns were not affected by the variations in depth of encoding across experiments.

Kensinger and Corkin (2003) support the findings that recollective memory is enhanced for emotional stimuli, especially, negative stimuli. They also used the 'remember/know' paradigm in their research in order to distinguish recollection and familiarity in a verbal recognition task. In this study, they examined whether individuals were more likely to remember details of presentation of negative words than those of neutral words. The results of the first experiment were consistent with the prior study (Ochsner, 2000); in that negative words were remembered or recollected more than neutral words. Additionally, familiarity or 'know' responses were slightly more frequent for negative words. They also supported the findings by conducting a source memory[9] task in addition to the recognition memory task. The words were shown as in the previous experiment, except in different colors, and then subjects were asked in which color the old item was presented. The results showed that participants had more detailed memories for negative stimuli such that they reported the colors of negative items more accurately then of neutral items. In addition to these results, the independent effect of high arousal and negative valence words were tested for recognition memory, source memory and recall. The findings revealed that high arousal words with neutral valence were recollected more frequently than negative words with neutral arousal and negative words were recollected more than neutral words. The familiarity pattern was similar to the recollection pattern as well. Thus, this study confirms that across all tasks, details associated with the presentation of words were more likely to be

[9] Source memory is the ‘where’ and ‘when’ component of episodic memory. Source memory includes contextual feature rather than content.

remembered for emotional items and there were also an enhancement of familiarity for emotional items.

Imaging studies (Sharot, Delgado & Phelps, 2004) also support the previous findings that although the overall accuracy of recognition does not change with emotional manipulations, recollection is enhanced for negative and high arousal visual stimuli. Sharot et al. showed that different subregions of medial temporal lobe have independent contributions to different recognition judgements of 'remember' and 'know' based on the emotionality of stimuli. Specifically, these findings indicate that the amygdala responds selectively to 'remember' judgments for emotional stimuli and the parahippocampus responds selectively to 'remember' judgements for neutral stimuli. These findings also support the idea that the amygdala plays a role in emotional memory, and the parahippocampus plays a role in perceptual information such as recognition of scene details. Activity in the hippocampus did not differ between emotional and neutral pictures for either 'remember' and 'know' judgements. Authors suggest that, because the hippocampus plays a role in the retrieval of semantic information, subjects rely on semantic information for both neutral and emotional pictures.

2.3 AGE RELATED CHANGES IN MEMORY AND EMOTION PROCESSING

In literature, there are many studies indicating some cognitive functions including sensory function and speed of processing decline from early to late adulthood (Cartensen & Mikels, 2005). Visual perception, attention deficits (Grady, 2000) and reduction in efficiency of inhibitory processes (Grady & Craik, 2000) also confound cognitive aging. Apart from lower level cognitive mechanisms, higher cognitive mechanisms also deteriorate. For example, deficits in memory (Grady, 2000; Grady & Craik 2000; Kensinger et al., 2005), reasoning and problem solving (Salthouse, 1996) and selective attention (Verhaeghen & Carella, 2002) are experienced throughout the life-span.

Cognitive processing decline is most observed in effortful and resource-intensive processing, relative to automatic processing (Cartensen, 2005). Some of the research on memory in aged population (Grady, 2000) gives insights for the difference of effortful and automatic processes. In general, there are only slight decrements in implicit memory which can be considered as evidence for intactness of automatic processing. Age-related changes in short-term memory are also slight, since older people can repeat back a short string of words, letters or numbers with almost equal accuracy. It has been postulated that older adults are impaired in consciously recollecting the events but relatively unimpaired in experiencing the familiarity of a recognised item. Therefore, in recognition memory tasks, due to the familiarity component, older adults show less decrement. The most age-related losses in memory involve free or cued recall tasks, because these tasks involve recollection of the original event or object explicitly (Grady & Craik, 2000). Recognition and recall tasks are measures of declarative memory therefore the impaired performance on these tasks are related with declined episodic memory function.

The decline in functioning of episodic memory may be due to changes in encoding and retrieval of the episodes in aging people (Grady, 2000), as well as an overall decline in the speed of processing. For example, there is some evidence that, older adults often have less activation of frontal areas during encoding, but bilateral prefrontal activation during retrieval (Cabeza et al, 1997). However, in younger adults, generally, there is an asymmetry of encoding and retrieval. There is an increased activity in left prefrontal cortex during encoding and an increase in the right prefrontal cortex during retrieval (Nyberg et al., 1998).

Aging affects memory through both encoding and retrieval processes. The most observed behaviour of older adults is the higher response time but there are several other findings regarding encoding and retrieval changes in older adults. First of all, when distinctive and non-distinctive encoding conditions are

represented, recollection is affected. Among two pairs of homographs[10] such as "organ-music, organ-heart" and "organ-music, organ-piano", the first two pairs are distinctive and the second two pairs are non-distinctive conditions. In younger adults, a study (Hay & Jacoby, 1999) showed that when encoding is under a distinctive condition, recollection is increased. However, this effect cannot be observed in older adults.

Howard et al. (2006) showed that the impairments in recognition memory due to aging mostly rely on recollection. They examined recollection memory of travel pictures in younger and older adults on the basis of the dual–process theory. They estimated the contribution of recollection and familiarity by using confidence ratings and ROC curves. Participants were required to study pictures and after one-day retention interval, they were required to participate in a recognition memory task. Participants were instructed to respond 'old' if they had seen the item and indicate a confidence level for that response. Recollection was estimated using the 'old' responses given with highest confidence, and familiarity was estimated from 'old' responses given with lower confidence. The findings showed that, although the reduction in overall accuracy was not very high, the reduction was especially observed for the contribution of recollection to recognition memory. The contribution of familiarity was found to be similar for both groups.

Adequate recollection requires retrieval of content and context of the episode. For example, the subject responds "I remember" if he remembers exactly what happened, where and when it happened. In recollection literature, answer to the "what" question is the "item memory", answer to "where" and "when" questions is the source memory. According to some research (Cabeza et al., 1997; cited in Grady and Craik, 2000) older adults, compared to younger adults, have reduced performance in both memory for items and source.

[10] Words which have the same spelling but differ in meaning

Moreover, the reduction in performance of memory for source is higher than the reduction in performance of memory for the item.

Another line of research (Craik & Tulving, 1975; cited in Grady and Craik, 2000) suggests that “deep” level of processing during encoding affects the results when compared to “shallow” encoding. What is meant by deep level of processing is elaborating the items in the study condition by making semantic decisions about the item. On the other hand, in the shallow level of processing there is only perceptual processing. The level of processing affects the retrieval of the items such that when semantic decisions are made about the items, memory for recollection improves, regardless of age. In deep level processing, both groups, young and old adults, show activation in left prefrontal areas (Grady and Craik, 2000).

Yet another possible perspective for the reduction in memory comes forward through divided attention. The performance of young adults on a task with a divided attention condition is similar to the performance of older subjects on a task without any manipulation in the attention condition. For example, Anderson (2000, as cited in Grady and Craik, 2000) used a paired associate task in a verbal recall experiment. Pairs of words were presented in the study and under the divided attention condition; subjects were required to make some association between the words. Then, in the test part, subjects were given the first word and required to recall the second associated word. The subjects showed impaired memory under the divided attention condition, similar to that shown by older adults under the control condition. Imaging studies also suggest that, aging and divided attention are associated with reductions in the left prefrontal cortex during encoding. Because, divided attention increases the load on attention, and leaves less space for memory encoding, it thereby reduces the activity in the left prefrontal cortex. Also due to cognitive aging, activation in the prefrontal cortex decreases.

Old adults experience less negative emotion as they pay less attention to negative stimuli, and become less likely to remember negative stimuli than positive (Mather & Carstensen, 2003). In order to exploit this finding, in a study, Mather et al. (2004) observed amygdala activation for negative and positive items. The imaging results showed that with age, the amygdala may show decreased reactivity for negative pictures and maintained reactivity for positive pictures. Participants were also asked to rate the pictures used in imaging task. Similar to the imaging results, the arousal ratings of negative pictures were significantly reduced for older adults. However, this reduction in ratings was not observed for positive pictures.

A study by Carstensen and Mikels (2005) revealed that older people tend to remember positive emotional stimuli better. Younger adults show tendency to remember negative stimuli as Ochsner (2000) suggested, but later, as they get older the tendency to remember negative stimuli yields to a tendency to remember positive stimuli. According to Cartensen et al. (2005), this positivity effect is not only present in the long-term memory, but also in the working memory. Old adults' positivity effect can be seen in the beginning of memory processes such as attention. When older adults are shown a negative face, they detect the negative face and avoid attending to it. On the other hand, when older adults are required to indicate the features of an object –e.g. a car-, they start with positive features unlike young adults. Thus, attention is an important component in encoding memory and older adults are positively biased in attention.

Kensinger et al. (2005) examined how memory is affected from central emotional and peripheral contextual details by presenting emotional and neutral pictures. However, this study does not take positive stimuli into consideration, only negative and neutral stimuli are presented with peripheral details. Emotional arousal is considered to focus the attention to a central object, especially when the central object has emotional valence (e.g. a gun). Thus, memory for central object is enhanced, reducing attention to neutral

peripheral details. They also showed that older and younger adults behave in similar patterns in a recognition memory task, which can be used as evidence for intactness in emotional memory. On the other hand, when the subjects were instructed that they were on a memory task, younger adults showed increase in remembering peripheral details, where as older adults could not change their strategy. Overall, however, the 'remember' responses for emotional stimuli were observed to be higher then neutral stimuli.

Finally, Thomas (2006) examined young and old adults' attentional bias and recognition memory for distracting emotionally valenced words in order to observe the influence of emotion in early processing and memory. In this study, participants were instructed to ignore emotional and neutral distracter words while making a simple digit parity judgement. The emotional distracter words were selected on the basis of valence which is negative, positive and neutral with controlled arousal - although for neutral valenced words arousal was significantly lower. Later, participants were given an incidental recognition task. The recognition findings were consistent with the literature in such a way that young adults tended to remember more negative stimuli and old adults tended to remember only positive stimuli. However, Thomas found no evidence of the expected positive attentional bias. Old adults' attention did not differ between the emotional distracter words, whereas young adults took longer to respond when the distracter word was negative. Thus, Thomas suggested that early processing biases did not fully explain age differences in recognition memory for emotional words.

2.5 THE CURRENT STUDY

Previous literature on the influence of emotions on memory does not differentiate between the contributions of arousal and valence separately. Although there have been studies that controlled arousal for positive and negative items, the arousal of neutral items in these studies was significantly lower than the arousal of items with positive and negative valence (Thomas

2006). Or in the analysis, items with high arousal and neutral valence were compared to items with neutral arousal and negative valence. To the best of our knowledge, no study investigated the effect of valence at three levels with controlled arousal in a systematic way. In order to exploit this, the present study aims to observe the effect of valence on recognition memory and how this effect varies due to aging. In addition, previous studies observed age and emotion effects on memory either for pictures or words, but not for both. The current study is designed to observe these effects on recognition memory for both verbal and visual stimuli in the same experimental setting.

According to a long tradition, visual stimuli are accepted to have greater effect on memory than verbal stimuli. The so called picture superiority effect was proposed by Paivio (1971), and it states that pictures show an enhancement in memory in terms of both recognition and recall. Thus, modality is an important factor in memory studies. This thesis exploited the use of different modalities in order to observe possible interactions between emotion and modality on recognition memory.

Additionally, previous research has been conducted in European and North American populations only. In the present study, however, the sample was chosen from a different culture in which there are Western, Eastern and Middle-Eastern cultural traces that have accumulated over centuries. Therefore, the present study should add non-Western findings to current literature.

CHAPTER 3

EXPERIMENTS

In the previous chapter, evidence was reviewed suggesting that, emotion has an effect on recognition memory and this effect varies due to normal aging (Ochsner, 2000; Kensinger & Corkin, 2003; Carstensen & Mikels, 2005). More specifically, enhanced memory was observed for items that carry emotional information. However, how much of this effect was due to valence and how much was due to arousal was not investigated in a systematic way. This chapter further investigates this effect, as well as the variation in this effect due to aging.

3.1 EXPERIMENT 1: METU TURKISH EMOTIONAL WORDS

120 Turkish words which are standardized in terms of emotional valence were needed for use in the verbal recognition memory task. Thus, a set of Turkish words was rated to provide a set of standardized words in terms of the emotional information they carry. This rating procedure was inspired from the Affective Norms for English Words (ANEW) which was developed by Bradley and Lang (1999).

As in ANEW, the dimensional view of emotions was used regarding the affective judgments while rating the words. The dimensional view assumes that emotion can be defined as values on a number of strategic dimensions (Osgood, Suci & Tannenbaum, 1957). According to Osgood, the changes in three orthogonal dimensions are accountable for the changes in emotion

assessments. The two primary dimensions are affective valence (ranging from unpleasant to pleasant) and arousal (ranging from calm to excited). The third, less related dimension, is dominance (ranging from controlled to in-control). The words are rated in terms of valence, arousal and dominance in order to standardize the emotional information they possess.

In order to assess the three dimensions of pleasure (valence), arousal and dominance in ANEW, the Self-Assessment Manikin (SAM) devised by Lang (1980) was used. SAM consists of figures which represent each dimension. In ANEW participants can bubble in the location corresponding to any of the 5 figures or between those figures. Thus a participant can rate each word in a 9-point scale for each dimension. Then for each word, valence, arousal and dominance means are calculated representing the emotional value of the word on a 9-point scale.

In our study, to assess the three dimensions of valence, arousal and dominance, the Manikin of Emotional Rating (MERT) was developed (Appendix A) as an alternative to SAM. Participants rated a subset of Turkish words using MERT. Then, as in ANEW, mean ratings of valence, arousal and dominance were calculated for each word.

3.1.1 Method

Participants

50 participants in three age groups, balanced in gender participated in this study. 20 young adults (21 - 31) with a mean age of 25.38 (*SD* = 2.75) years, 20 middle-age adults (34 - 58) with a mean age of 50.22 (*SD* = 7.62) and 10 old adults (62 – 80) with a mean of 71.90 (*SD* = 7.44) participated as volunteers. Young adults, middle age adults and old adults had an average of 16.33 (*SD*= 1.53), 16.94 (*SD* = 2.62) and 14.90 (*SD*= 1.66) years of education, respectively. All participants were native Turkish speakers.

Materials

The words currently included in this study are translations of a subset of words chosen from ANEW. The original words were selected based on their valence and arousal ratings in ANEW. At first, the words were divided into three groups in terms of their mean valence ratings by calculating the mean (5,15) and the standard deviation (1,99) of mean valence ratings. The cut-off points were calculated by adding the standard deviation to the mean and subtracting the standard deviation from the mean. The words with a mean valence rating below 3.16 were considered as negative, mean valence rating between 3,16 and 7,15 as neutral and mean valence rating above 7,15 as positive. Then, for each group (positive, negative and neutral) the same classification was done for mean arousal ratings. First, the mean (4,95) and standard deviation (1,06) of mean arousal ratings were calculated. Then, the words with mean arousal ratings falling between one standard deviation distance from the mean of arousal ratings were selected (words which have mean arousal ratings between 3,89 and 6,01) as words with neutral arousal. Thus, the selected words were comprised of three classes of words in terms of mean valence rating (positive, neutral and negative) with only neutral mean arousal rating. Then, the selected words were translated and adapted to Turkish considering cultural differences.

On another front, MERT, an affective rating system which comprises the three emotional dimensions as graphical illustrations of a face sketch, was developed. MERT figures are based on bipolar scales and for each scale (valence, arousal, dominance) there are 5 face figures representing the values of the scale as presented in Appendix A. For the pleasure dimension, MERT ranges from a smiling happy face figure to an unhappy face figure. To represent the arousal scale MERT ranges from an excited face figure to a calm, sleepy face figure. Finally, MERT ranges from a large face figure (representing “in-control”) to a small face figure (representing “dominated”) for the third scale, dominance. In MERT, participants could mark the squares directly

underneath these five face figures, as well as the squares between these five figures, which results in a nine-point ranging scale for each dimension.

Procedure

Experiments were run individually or in groups of 2 to 4. Each participant rated 239 Turkish words for pleasure, arousal and dominance by using MERT booklets. Unlike SAM, MERT consists of 3 booklets. For each emotional dimension there is a different booklet. In SAM, subjects rated each word in three dimensions before working on to the next word. However, in MERT subjects rated all of the words in a separate booklet for valence, then they worked on through the same words in a separate arousal booklet, and finally worked through the entire list in a dominance booklet. In order to increase the pace of each subject and to make it easier for the subject to decide on where the word falls in terms of emotional value, using different booklets for each dimension is thought to be more convenient.

3.1.2 Results and Discussion

After subjects had rated each word for pleasure (valence), arousal and dominance, the mean valence, arousal and dominance were computed for each word, using a database developed in MS Access. In Appendix B, 239 Turkish words and their valence, arousal and dominance mean ratings and standard deviations can be found. Figure 4 depicts the two-dimensional space for mean arousal and mean valence of each word. As seen from the figure, mean pleasure ratings for words are distributed across the space. This means that the rated words were distributed across all categories of valence (positive, neutral and negative). However, mean arousal ratings for words were distributed mostly between 4 and 8, showing that the rated words were distributed across only neutral and high arousing categories. Only 7 out of 239 words were rated as representing the negative arousal (calm) category. For example, according to this rating the lowest arousal mean is 2,87 for the word “sükunet” (tranquility). Thus, the results of Experiment 1 showed that among the 239 words rated normatively, 120 words with positive, neutral and negative valence and neutral arousal could be selected to be used in Experiment 2.

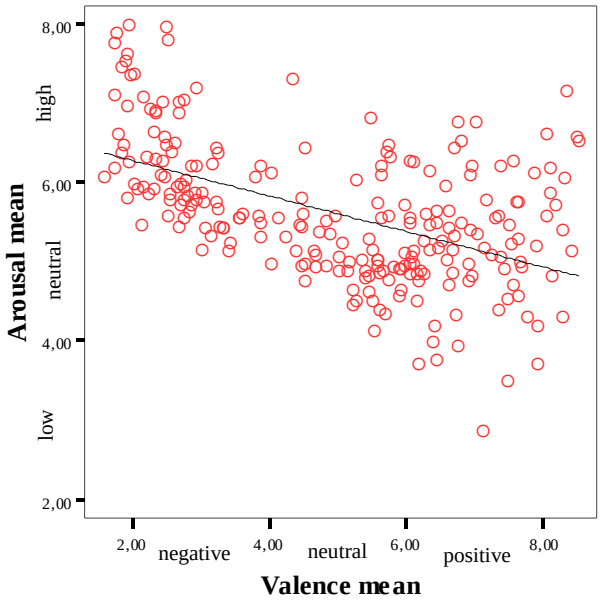


Figure 4 2-dimensional space of the emotional normative ratings of a subset of Turkish words

3.2 EXPERIMENT 2: EFFECTS OF EMOTION ON RECOGNITION MEMORY

This experiment was designed to observe age related changes in recognition memory for words and images with emotional valence. The aim was to explore the effect of valence and the modality of presentation of stimuli in recognition memory for elderly adults.

Previously, researchers have investigated the effect of emotions and aging on memory, both in separate and in the same experimental settings and the effect of emotions was examined both for verbal and visual stimuli with different levels of valence and arousal. In these studies emotional valence was allowed to vary as well as emotional arousal. To the best our knowledge, there is only one study (Thomas, 2006) which controlled arousal for positive and negatively valence words, but in that study the arousal level of neutral words were relatively lower. In this study, the aim was to control arousal in all levels of

valence. Moreover, in this research, the verbal and visual recognition memory tasks were conducted in two immediate sessions.

Additionally, in this study, two methods were used for estimating measures of recognition memory; 'Remember/Know' judgments which depend on the dual process theory and 'Old/New' judgments which depend on signal detection theory of recognition memory.

Moreover, the effect of abstractness or concreteness of words on verbal recognition memory was investigated. Since investigating the effect of abstractness was not among the initial aims of this thesis, abstractness was controlled to a limited extent. A similar analysis on the effect of picture complexity on visual recognition memory could not be carried out, since the means for classifying picture complexity are beyond the scope of this thesis.

Hypotheses:

The first hypothesis rests on the evidence from the previous research that older adults tend to be less accurate in overall recognition memory performances regardless of modality of presentation and valence.

The second hypothesis draws from the literature on the picture superiority effect in memory (Rajaram, 1993) suggesting that overall recognition memory performances would be higher for images compared to words.

The third hypothesis rests on the findings that positive and negative emotional stimuli were more accurately recognized compared to neutral stimuli. In literature (Ochsner, 2000; Kensinger & Corkin, 2003; Charles, Mather & Carstensen, 2003, Thomas 2006) emotional effects on memory have been observed when the stimuli contained high and low variations of both valence and arousal. How much of this effect is due to valence and how much is due to arousal has not been addressed so far. By limiting the arousal component to only neutral variation, the effect of valence on memory was tested. It is

hypothesized that if the emotional enhancement of memory is limited to arousing contents due to the contribution of amygdala, no significant effects will be observed by varying valence.

Finally, if there is an effect of valence on recognition memory, an interaction of age and valence is hypothesized, such that younger adults recognize more negative valence items and older adults recognize more positive valence items.

3.2.1 Method

Participants

21 young adults (21 - 30) with a mean age of 25.33 (*SD* = 2.18) years, 19 old adults (60 – 80) with a mean age of 67.31 (*SD* = 6.96) participated as volunteers. Young adults and old adults had an average of 16.76 (*SD*= 1.48) and 14.90 (*SD*= 2.33) years of education, respectively. All participants were native Turkish speakers and mean the Minimental Examination[11] (MMST) score of old adults was 29.57 (*SD* = .69). Data from three older adults were replaced due to either computer problems (one) or low accuracy in recognition task (two participants responded 'new' to all items presented in the test session in the verbal recognition task).

Design

The design was a 2 (age: young, old) X 3 (valence: negative, neutral, positive) X 2 (modality of presentation: verbal, visual) mixed factorial design with age between subjects, valence and modality within subjects. The dependent measures are estimated recollection from 'Remember' responses, estimated familiarity from 'Know' responses and estimated recognition accuracy from both 'Remember' and 'Know' responses.

[11] MMST is a brief and quantitative measure of cognitive status in adults. MMST is used to screen the cognitive impairment and severity of the impairment by measuring reading, comprehension, writing and drawing skills. It has been determined that MMST is valid and reliable in the diagnosis of demantia in the Turkish population, with an ideal threshold score of 23 or 24 out of 30 (Güngen et al, 2002).

Materials

Verbal Recognition Task - 120 words from Experiment 1 were selected for use as verbal stimuli (See Appendix C for list of words). The aim was to select words with three levels of pleasure (valence) with neutral arousal. The emotional valence scores of words with positive (*M*=7.42, *SD*=0.52), neutral (*M*=5.78, *SD*=0.34) and negative (*M*=3.05, *SD*=0.68) pleasure levels differed significantly from each other $F(2,117) = 694.42$, *MSe*=195.40. Figure 5 depicts the distribution of valence mean in three classes of valence; negative, neutral and arousal. The arousal levels for positive (*M*=5.46, *SD*=0.48), neutral (*M*=5.38, *SD*=0.55) and negative (*M*=5.58, *SD*= 0.29) words did not differ significantly $F(2,117) = 1.99$, *MSe* = 0.41. Thus, the effect of arousal was confined to only neutral values. Figure 6 shows the distribution of arousal mean in three classes of valence.

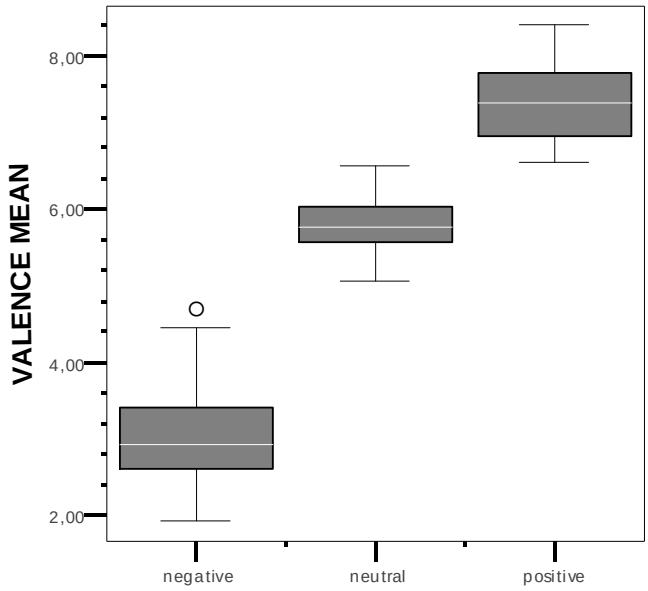


Figure 5 Valence Means of Words Selected as Negative, Neutral and Positive Valence

The words were divided into two sets of 60 words consisting of 20 positive valence, 20 neutral valence and 20 negative valence words in each set. The two groups were designated as Set A and Set B and their use as study items were

counterbalanced across participants. Whenever possible, the words in Set A and Set B were counterbalanced as well in terms of semantic proximity. For example, the word ‘yelkenli’ (sailboat) in Set A was counterbalanced by the word ‘gemi’ (boat) in Set B. 28 words were semantically proximate hence 14 of them were placed in set A and 14 of them in set B. Two study lists were constructed with one from Set A and the other one from set B. The words in the study lists were placed in a pseudorandom order such that no three words of the same valence occurred in succession.

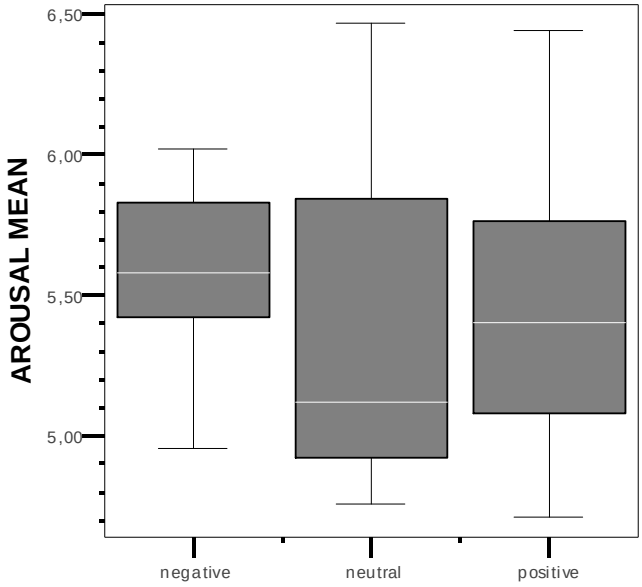


Figure 6 Arousal Means of Words Selected as Negative, Neutral and Positive Valence

A test list was constructed from both Set A and Set B resulting in 120 words consisting of 40 positive, 40 neutral and 40 negative, 20 of each were seen before in the study list. The words were placed in a random order.

Visual Recognition Task – 120 pictures from International Affective Picture System (IAPS) (Lang et al., 2005) were selected as visual stimuli (See Appendix D for list of pictures). The normative ratings involved in IAPS were carried out on a North American sample. A similar study was not conducted

using a Turkish sample for the purposes of this thesis, as Verschuere, et al. (2001) found the cross-cultural validity of IAPS by comparing ratings of Flemish and North American samples. For this thesis, arousal scores are controlled in the visual recognition task using normative ratings from IAPS. The emotional valence scores of positive (*M*= 7.54, *SD*= 0.35), neutral (*M*= 5.95, *SD*= 0.73) and negative (*M*= 3.18, *SD*= 0.54) pictures differed significantly from each other $F(2,117) = 624.93$, *MSE*= 194.47 (Figure 7). The arousal levels for positive (*M*= 4.98, *SD*= 0.56), neutral (*M*= 5.01, *SD*= 0.56) and negative (*M*= 5.07, *SD*= 0.65) pictures did not differ significantly $F(2,117) = 0.26$, *MSE* = 0.09 (Figure 7).

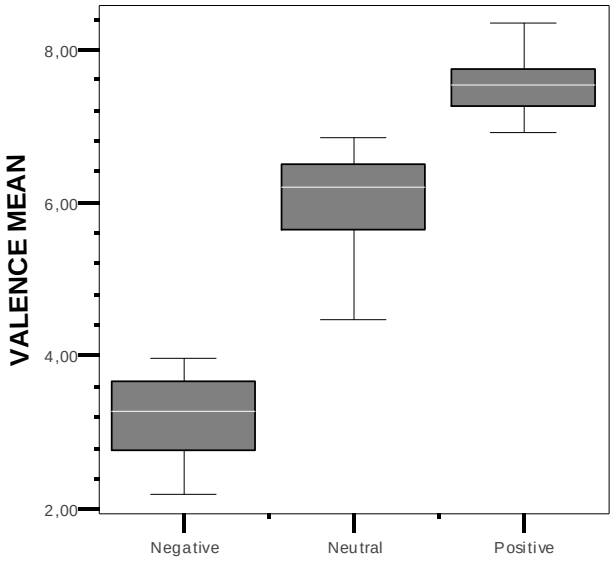


Figure 7 Valence Means of Pictures Selected as Negative, Neutral and Positive Valence

The pictures were also divided into two sets of 60 pictures consisting 20 positive, 20 neutral and 20 negative valence pictures. These two sets were again named as Set A and Set B and used as study lists which was counterbalanced across participants. Set A and Set B were also matched for content in most of the pictures. For example, if there was a snake picture in Set A, there would be another snake picture in Set B. Similarly, 36 pictures were

similar in content so 18 pictures were in Set A and 18 in Set B. The pictures were placed in pseudorandom order in a way that at most two pictures of same valence occurred sequentially.

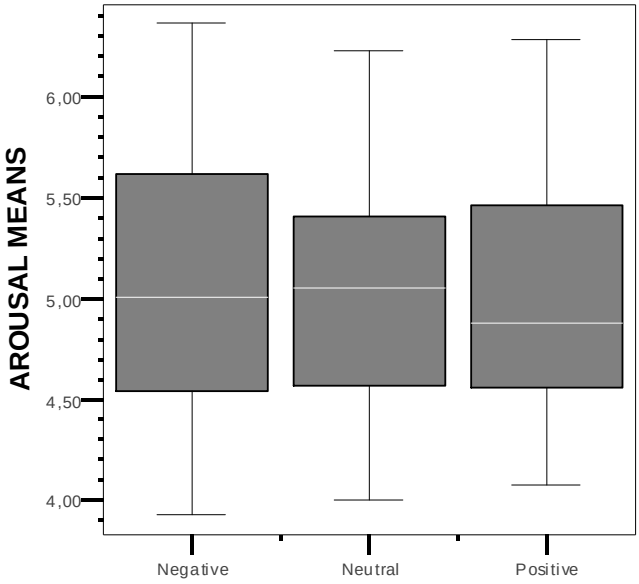


Figure 8 Arousal Means of Pictures Selected as Negative, Neutral and Positive Valence

The test list was consisted of both Set A and Set B. The test list, thus, was composed of 120 pictures: 60 new and 60 studied with 20 positive, 20 neutral and 20 negative valence pictures. The pictures in the test list were presented in random order.

Procedure

All participants took part in two study sessions; one verbal and one visual study session, lasting approximately two and four minutes, respectively. After a one-hour retention interval, participants took two test sessions lasting approximately ten minutes each. The one-hour retention interval was decided upon based on the literature (Rajaram, 1993). All photographs were shown in full screen mode, and all the words were shown at the center on a personal

laptop. The software program SuperLab Pro was used for presentation of study and test stimuli, as well as response collection.

At the beginning of the study sessions, participants were instructed that they were going to see words and pictures and would be asked to come back after an hour for the test sessions. Each participant saw study sessions of photographs and words consecutively, and the order was counterbalanced within and across each group. Similarly, after the retention interval, they saw both test sessions in succession. The instructions were given orally by the experimenter, based on the instructions given by Rajaram (1993) (See Appendix E for instructions).

In the verbal recognition task, for each trial in the study session, participants saw the word for one second with a 750-ms pause in between trials. In addition to this, participants were asked to think whether the word was abstract or concrete, in order to make sure they attend to the word. Similarly, in the visual recognition task, for each trial in the study session, participants saw the photograph for two seconds with a 750-ms stimulus interval between photographs. In this task, participants were required to think whether the picture was visually complex or not. The abstractness and the complexity judgments of the participants were neither procured nor measured. Those judgments were required solely to make sure they attended to the study item.

A one-hour retention interval was administered after the study session, during which participant activities were not controlled. After the retention interval, in both test sessions, participants were instructed that they would see some new and old items, and they were required to discriminate old items from new items. The instructions explained that they could discriminate the items by pressing one of the three keys; If they thought they remember the item, they pressed red key (“A” on the keyboard); if they thought they knew the item, they pressed yellow key (“H” on the keyboard) and if they decided that the item is new, then they pressed the green key (“I” on the keyboard). The keys were chosen such that the spatial distances between them were maximized on

the Turkish keyboard. Photographs and words remained on the screen until participants indicated their response. After the completion of the tasks, participants were given a debriefing.

3.2.2 Results and Discussions

Recollection versus familiarity: In order to estimate the contributions of recollection and familiarity on recognition memory, 'Remember' and 'Know' responses were transformed according to the model of Yonelinas et al. (1996). The recollection index which represents the contribution of recollection to recognition memory, was estimated using the formula

$$Rec = \frac{\left(R_{old} - R_{new}\right)}{\left(1 - R_{new}\right)} \tag{3}$$

where *Rec* denotes Recollection Index, R_{old} is "remember" responses for studied items (Hits), R_{new} stands for proportion of "remember" responses for non-studied items (False Alarms).

In order to estimate the familiarity index which represents the contribution of familiarity, first familiarity estimates of hits and false alarms were calculated based on the independence assumption. The formula is

$$F_{old} = \frac{K_{old}}{(1 - R_{old})} \tag{4}$$

where F_{old} denotes the familiarity estimate due to "know" responses given to studied items, K_{old} represents the proportion of "know" responses for studied items and R_{old} is "remember" responses for studied items.

Similarly, the familiarity estimate of false alarms were calculated as

$$F_{new} = \frac{K_{new}}{(1 - R_{new})} \quad (5)$$

where F_{new} is the familiarity estimate due to "know" responses given to non-studied items, K_{new} denotes the proportion of "know" responses given to non-studied items and R_{new} is the proportion of "remember" responses for non-studied items.

After finding F_{old} and F_{new}, the Familiarity index (Fd') can be calculated by using signal detection theory, as follows

$$F\,d' = z(F_{old}) - z(F_{new}) \quad (6)$$

where Fd' is the familiarity index and $z(x)$ is the z-transform

Table 1 Mean Recollection and Familiarity index of young and old adults as a function of valence and modality

		Verbal		Visual	
Age	Valence	Rec	Fd'	Rec	Fd'
Young Adults	Negative	0,51	1,19	0,66	2,01
	Neutral	0,50	1,21	0,64	1,71
	Positive	0,51	1,16	0,64	1,74
Old Adults	Negative	0,45	0,51	0,64	0,98
	Neutral	0,46	0,52	0,57	1,01
	Positive	0,38	0,18	0,62	0,73

Table 1 shows the recollection index (Rec) and familiarity index (Fd') for visual and verbal recognition tasks. In order to compare the effects of valence

(negative, neutral, positive), modality (word, picture) and age (young, old), a 3 X 2 X 2 ANOVA was conducted on the estimated recollection and familiarity indices. For recollection, the main effect of the modality of presentation was found to be significant $F(1,36)=38.01$, $MSe = 1.46$, $p<.000$. Recollection was higher for pictures than words. As a function of valence and age, recollection did not differ significantly as the interactions were not significant. For familiarity, the main effect of age $F(1,36) = 12.64$, $MSe = 6.76$, $p<.001$ and main effect of modality $F(1,36) = 20.89$, $MSe = 18.23$, $p<.000$ was significant. The main effect of valence was not significant, but it approached significance with $F(2,72) = 2,73$, $MSe = .957$, $p<.072$. Contrasts reveal that positive valence stimuli were tended to be less familiar to all participants, $F(1,36) = 5.53$, $MSe = 1.79$, $p<.024$.

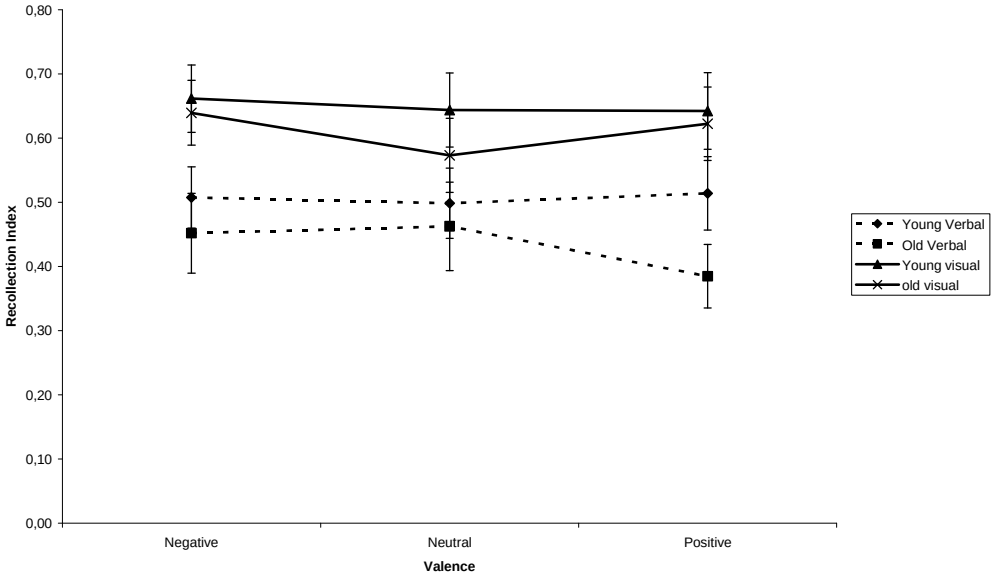


Figure 9 Effect of valence on recollection index (Rec)

The ANOVA on estimated recollection revealed that there is only a significant difference between only visual and verbal recognition tasks. The overall recollection estimate was higher in visual recognition tasks than verbal recognition tasks (Figure 9). The main effects of valence and age were found to be insignificant, indicating that recollection was only affected by the modality

of presentation. For familiarity estimates, in addition to modality of presentation, age was also an effect, in a way that older participants tend to be less familiar to study items compared to younger participants (Figure 10). In other words, these results suggest that according to dual process theory, familiarity accounts for age-related changes in recognition memory.

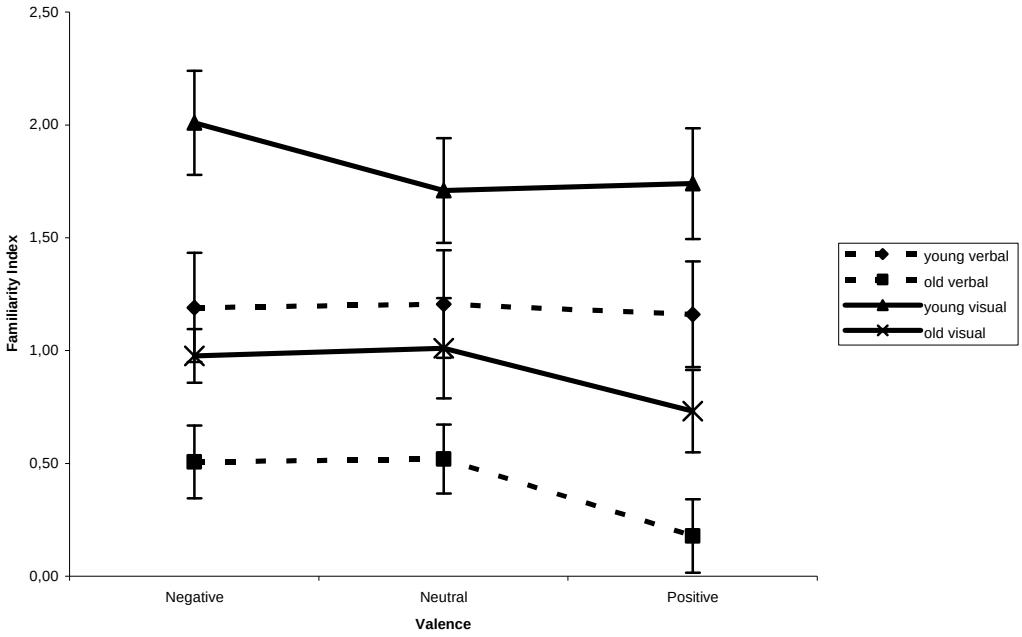


Figure 10 Effect of valence on familiarity index (Fd')

Recognition Accuracy: In this study, recognition memory is measured with regard to both the dual process theory and signal detection theory. The index of recognition accuracy (d') which is the distance between the means of the memory strength distributions of studied items and non-studied items, was computed from signal detection theory as

$$d' = z(Hits) - z(FAs) \tag{7}$$

where d' is recognition accuracy, *Hits* denote proportion of 'Old' judgments given to studied items and *FAs* denotes proportion of 'Old' judgments given to

non-studied items. ‘Old’ judgments represent the sum of ‘Remember’ and ‘Know’ judgments.

The larger values of d' indicate greater sensitivity to discriminate old from new items, hence greater recognition accuracy.

The results from the recognition tasks are presented in Table 2, which displays the proportion of hits and false alarms, and recognition accuracy as a function of valence (negative, neutral, positive), age (young, old) and modality of presentation (word, picture). A 3 X 2 X 2 ANOVA was conducted on recognition accuracy, hits and false alarms to compare the effects of valence, modality and age. Overall, younger adults were more accurate than older adults $F(1,38) = 33.73$, $MSe = 10.55$, $p<.000$, and pictures are recognized more accurately than words $F(1,38) = 72.33$, $MSe = 57.23$, $p<.000$. The main effect of valence $F(2,76) = 5.57$, $MSe = 1.23$, $p<.006$ was significant. Contrasts revealed that positive stimuli were recognized significantly lower than negative $F(1,38) = 9.13$, $MSe = 1.80$, $p<.004$, and neutral stimuli $F(1,38) = 8.73$, $MSe = 1.90$, $p<.005$.

Table 2 Measures of Performance as a Function of Valence, Age and Modality

		Verbal			Visual		
Age	Valence	Hits	FAs	d'	Hits	FAs	d'
Young Adults	Negative	0,77	0,21	1,88	0,87	0,08	3,01
	Neutral	0,77	0,18	1,94	0,86	0,07	2,96
	Positive	0,78	0,28	1,71	0,86	0,08	2,88
	Overall	0,77	0,22	1,52	0,86	0,08	2,53
Old Adults	Negative	0,74	0,42	1,05	0,81	0,22	1,87
	Neutral	0,74	0,39	1,10	0,75	0,19	1,83
	Positive	0,71	0,48	0,68	0,76	0,24	1,68
	Overall	0,73	0,43	0,79	0,77	0,22	1,53

The experimental manipulations on overall recognition accuracy were able to show differences between age, modality of presentation and valence. As shown before, young adults were more accurate in discriminating old visual and verbal items from new ones compared to old adults. Moreover, when pictures were presented, the accuracy in recognition increased compared to verbal presentation. The main effect of valence was also significant. In other words, positive valence stimuli were less accurately recognized than negative and neutral stimuli, as depicted in Figure 11.

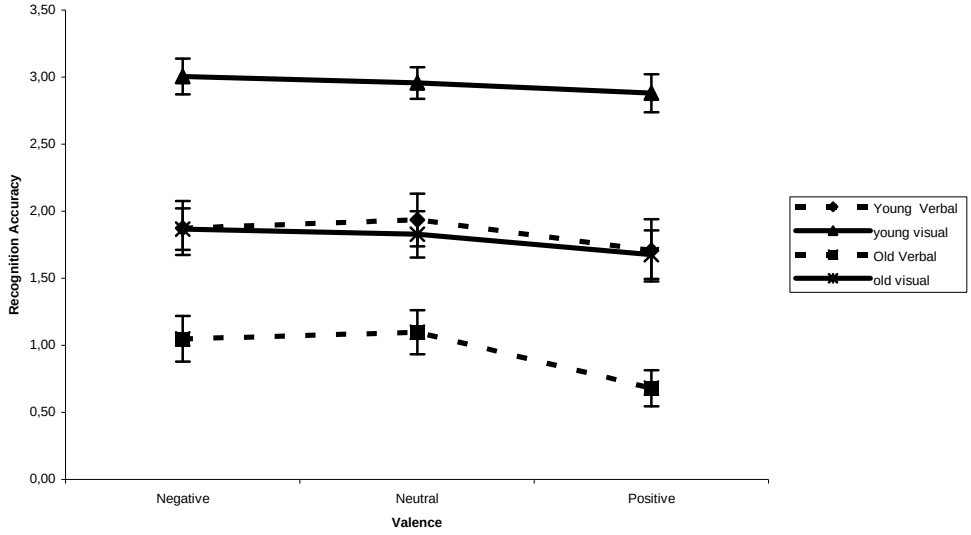


Figure 11 Effect of valence on recognition accuracy

Further analysis on hit rates and false alarm rates showed that for hits, there is only a main effect of modality in a way that hit rates for pictures are significantly higher than hit rates of words $F(1, 38) = 13.24$, $MSe = 0.27$, $p<.001$. As for false alarm rates, older adults had significantly greater false alarm rates than younger adults $F(1,38) = 15.96$, $MSe = 0.31$, $p<.000$. The main effect of valence was also significant $F(2,76) = 11.76$, $MSe = .07$, $p<.000$. The false alarms of positive stimuli was significantly higher than that of negative and neutral stimuli, $F(1,38) = 9.76$, $MSe = .048$, $p<.003$ and $F(1,38) = 21.20$, $MSe = .14$, $p<.000$, respectively. False alarm rates were also significantly

higher for verbal stimuli $F(1,38) = 37.67$, $MSe = 2.00$, $p<.000$. The results also show that there is a significant interaction of valence and modality $F(2,76) = 3.82$, $MSe = .02$, $p<.026$. Contrasts reveal that when the modality of presentation is verbal, the false alarm rates are significantly higher than when the modality of presentation is visual $F(1,38) = 6.840$, $MSe = .161$, $p<.013$.

Age differences showed no effect on hit rates but showed an effect on false alarm rates (Figure 12). More specifically, the decrease in the overall recognition performance depends on the increase in false alarm rates when people get older. In other words, older people perform at the same accuracy level as younger people while recognizing the study item. However, old adults have a poorer performance compared to young adults, when discriminating new items. They tend to respond "old" even when the item was not presented before. Valence differences of stimuli also showed no effect on hits but showed an effect on false alarm rates. When the stimuli were positive, the false alarm rates were higher compared to negative and neutral stimuli. Thus, the valence effect on the overall recognition accuracy could be caused by the higher false alarm rates on positive stimuli. Finally, differences in modality of presentation affected both hits and false alarms. Hits were higher for pictures than for words and false alarms were higher for words than for pictures, which is consistent with the finding that overall recognition accuracy was higher for pictures than for words. There was also an interaction of valence and modality for false alarms, showing that false alarm rates were higher for positive verbal stimuli than for positive visual stimuli. This result indicates that it is more likely that a new positive valence word would be considered as a studied word than a new positive valence picture being considered as a studied picture.

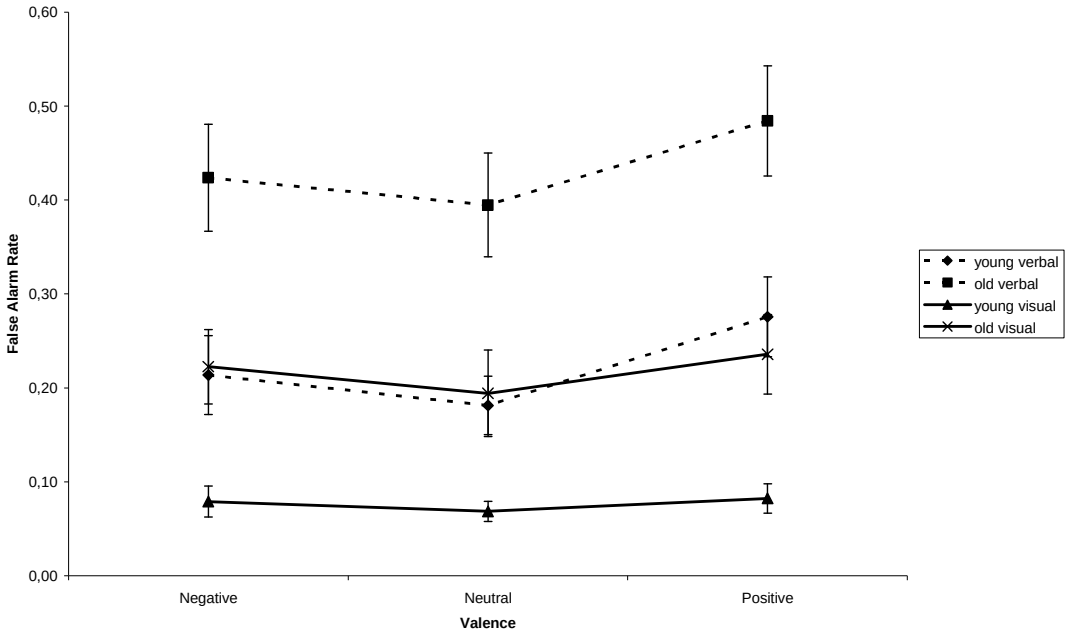


Figure 12 Effect of valence on false alarm rates

Reaction Times: A 3 X 2 X 2 ANOVA was conducted on reaction times of hits and false alarms in order to analyze the main effects of age (young, old), valence (negative, neutral, positive) and modality (word, picture). There was no significant main effect of reaction times of hits. However, there was a main effect of age F (1,38) = 10.84, p<.002 and modality of presentation F(1,38) = 20.00, p<.000 for false alarms. Older adults had higher reaction times for false alarms compared to younger adults t(38) = 3.30, p=.002. Reaction times for false alarms were also higher when the stimulus was a picture t(39) = 4,47, p=.000. However, this effect comes from the interaction of modality and age F(1,38) = 6.45, p<.015 in a way that reaction times of false alarms did not differ significantly between modalities for younger adults. For older adults, the reaction times of false alarms were higher for pictures.

The difference between age groups was significant considering the reaction times for false alarms. As previously stated, false alarm rates, as well as reaction times were higher in older adults compared to younger adults. A reverse pattern can be observed for the changes in modality of presentation and

age. Even though the false alarm rates were higher for verbal stimuli compared to visual stimuli, the reaction times for verbal stimuli were lower than reaction times for visual stimuli for older adults. In other words, older adults made more wrong decisions on verbal stimuli compared to visual stimuli, and they made those wrong decisions for verbal stimuli more quickly than they did for visual stimuli.

Table 3 Reaction Times (msec)

		Verbal		Visual	
Age	Valence	Hits	FAs	Hits	FAs
Young Adults	Negative	1902	2013	1895	1758
	Neutral	1891	1804	1839	1617
	Positive	1987	1596	1909	3209
Old Adults	Negative	2036	2226	2165	3937
	Neutral	1937	1982	2289	2849
	Positive	2236	2293	2073	3966

Abstract versus Concrete: Further analysis was conducted to observe the effects of abstractness of words. The level of abstractness of each word was determined subjectively by the author on a binary scale: a word could be either abstract or concrete. Since investigating this effect was not among the initial aims of this study, the distribution of abstract words and concrete words was not balanced. However, abstract and concrete words were distributed evenly across Set A and Set B which were study items and lures. Table 4 shows the number of words that fall into each category.

Table 4 Number of Abstract and Concrete Words in Set A and Set B

	Valence	Abstract	Concrete
Set A	Negative	8	12
	Neutral	6	14
	Positive	7	13
	Total	21	39
Set B	Negative	6	14
	Neutral	6	14
	Positive	8	12
	Total	20	40
Total		41	79

Recognition accuracy was found by Formula (6), which calculates signal detection theory statistics d' from hit rates and false alarm rates. Table 5 displays recognition accuracy as a function of valence (negative, neutral, negative), age (young, old) and abstractness/concreteness of the verbal recognition memory experiment. This analysis was done by conducting a 3 (valence) X 2 (abstract, concrete) X 2 (age) ANOVA on recognition accuracy. The results indicated that there was a main effect of age $F(1,38) = 13.64$, $MSe = 9.42$, $p<.001$, as found previously, younger adults were more accurate in discriminating old words from new ones compared to older adults. The interaction of age and valence was found to be significant $F(2,76) = 3.25$, $MSe = 2.49$, $p < .044$, indicating that older adults were less accurate in positive words $F(1,38) = 6.23$, $MSe = 4.71$, $p < .017$. Finally, the interaction of age and valence and abstractness /concreteness of words was found to be significant $F(2,76) = 2.89$, $MSe = 1.35$, $p <.010$. Old adults were less accurate in abstract words when they were neutral and positive compared the young adults, $t(38) = 2.81$, $p=.008$ and $t(38)=4.68$, $p<.000$. This kind of interaction was not found in concrete words.

Moreover, 3(valence; negative, neutral, positive) X 2(age; young, old) ANOVA was conducted on recognition accuracy of concrete words. The results indicate that there was a main effect of age $F(1,38) = 9.48$, $MSe = 20.23$, $p<.004$ which was reported above and also valence $F(1,38) = 5.53$, MSe

= 2.12, p = .006. Further t statistics revealed that negative concrete words were more accurately recognized compared to neutral and positive concrete words, $t(39) = 2.35$, p=.024, $t(39) = 2.85$, p=.007.

Table 5 Recognition Accuracy of Abstract and Concrete Words

		d'	
Age	Valence	Abstract	Concrete
Young Adults	Negative	1,60	2,16
	Neutral	2,24	1,86
	Positive	2,28	1,68
Old Adults	Negative	1,28	1,32
	Neutral	0,96	1,00
	Positive	0,52	0,90

Age differences showed effect on overall recognition accuracy on words, both abstract and concrete (Figure 13). Younger adults were more accurate in recognizing abstract and concrete words than older adults. There was also a significant main effect of valence on concrete words, which is negative concrete words were more accurately recognized for all participants. For both concrete and abstract words, there was also an interaction of age and valence showing that old adults were less accurate for positive words compared to younger adults. This interaction had only approached significance in the analysis of overall recognition accuracy, while it reached significance in this analysis. This difference was observed, because in this analysis words were divided into two categories; abstract and concrete. Due to this division, two separate d's were calculated for each valence group. Thus the means and variances of these d's, and the means and variances of the d's from the overall recognition accuracy may differ. Finally, the difference of valence and age was significant for abstract words such that the pattern of corrected recognition for abstract words changes with the manipulations in valence. As Figure 13 shows,

younger adults were more accurate in neutral and positive abstract words; however older adults were relatively more accurate in negative abstract words compared to positive and neutral abstract words. The figure also shows that the accuracy for negative abstract words did not change with age, but the accuracy of neutral and positive abstract words got lower, positive abstract words even lower.

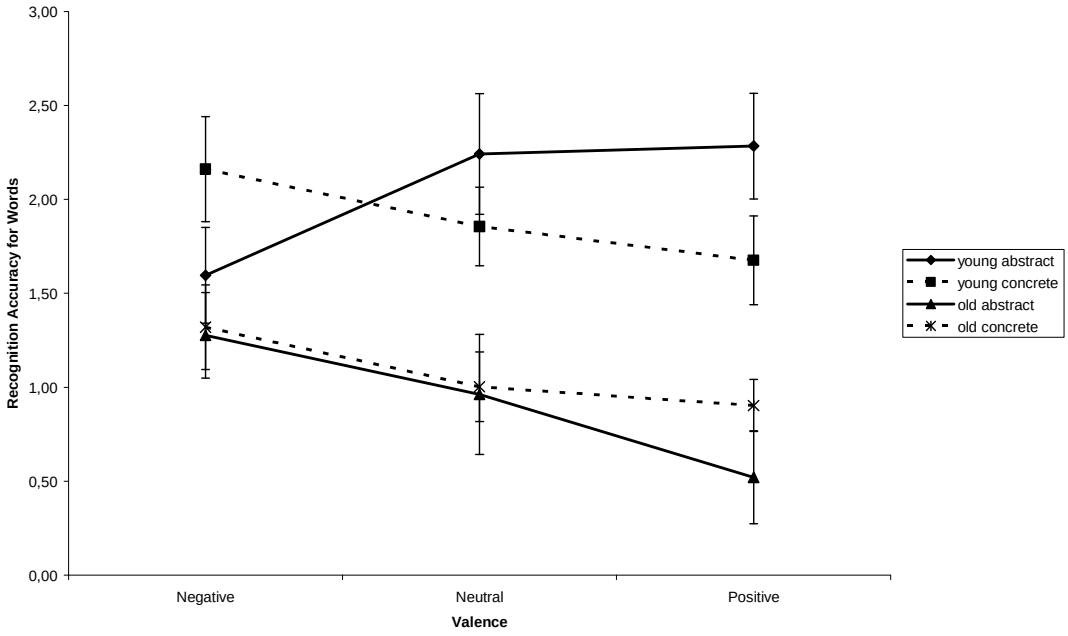


Figure 13 Effects of valence on abstract and concrete words

CHAPTER 4

GENERAL DISCUSSIONS

This study investigated age-related differences in recognition memory for emotional stimuli. Specifically, the effect of valence was studied in young and old adults for both visual and verbal recognition memory. The verbal and visual stimuli were controlled for arousal, thus allowing for observing only the effect of valence on aging and memory. This study showed that in a Turkish sample, the pattern of accuracy in recognition memory did not change with respect to valence between different age groups. The findings are discussed below in comparison to previous studies.

4.1 EXPLANATION OF FINDINGS

4.1.1 Normative study on Turkish emotional words

In Experiment 1, a subset of Turkish words were selected and normatively rated for valence, arousal and dominance values. Mean valence of these normed words were distributed across all values of valence such as negative, neutral and positive. On the other hand, mean arousal of these normed words were distributed across only neutral and high arousal classes. The reason why the normative words with low arousal ratings are few could be explained by the method for selecting words for this study. Since only neutral arousal words were needed for Experiment 2, only words with neutral arousal ratings was chosen from ANEW. Those words/concepts were then translated into Turkish and normatively rated for valence, arousal and dominance. The findings of this

initial experiment created verbal stimuli with appropriate features for the next experiment, which is the verbal recognition memory experiment. Verbal stimuli consisted of words with valence values representing three categories; positive, neutral and negative; and arousal values representing only the neutral category.

During the course of this study, another set of ratings on emotional Turkish words have been found (M.A. Smith, personal communication, July 12, 2007). These ratings were being collected using Self Assessment Manikin (SAM) as an ongoing study on a larger set of words, however we were unable to use them because the rating process has not been finished. Still, to validate using MERT as the rating material, we cross correlated 36 words that existed in both rating studies. As a result, we found that the valence, arousal and dominance means of these words were significantly correlated, $r = .93$, $p<.000$, $r = .71$, $p< .000$, $r = .79$, $p<.000$, respectively.

4.1.2 Modality effects on recognition memory

In Experiment 2, as expected, due to the picture superiority effect, pictures were more accurately recognized across all participants than words. Rajaram (1993) reported a picture-superiority effect on overall recognition. Similarly, in this study, familiarity and recollection were found to differ with respect to modality of presentation. When pictures were presented, the contribution of both familiarity and recollection were higher in comparison to the presentation of words. In addition, visual items received more correct 'old' responses compared to verbal items. Together with higher hits for visual items, lower false alarms for visual items support the finding that visual stimuli was more correctly recognized than verbal stimuli.

4.1.3 Valence effects on recognition memory

Ochsner (2000), Kensinger and Corkin (2003), Sharot et al. (2004) stated that the contribution of familiarity to recognition memory did not differ with respect to valence, since familiarity was an automatic process. Analysis on

'know' judgments supported the previous findings. Familiarity component of recognition memory found not to differ with respect to valence. However, Ochsner (2000), Kensinger and Corkin (2003), Sharot et al. (2004) stated that the contribution of recollection to recognition memory differed with respect to valence. Previous studies found that contribution of recollection was highest for negative items. The present study failed to found an effect of valence on recollection process. This inconsistency of the findings for the contribution of recollection may be due to 'remember/know' judgments per se. Debriefing with the subjects indicate that participants might have understood the 'remember/know' judgment more like 'sure/unsure' judgment.

Valence is found to be effective in the analysis of false alarms. For positive items, the false alarm rates were higher regardless of age and modality. This finding is also consistent with the finding that response bias[12] differs across valence conditions (Dougal and Rotello, in press). In this experiment, higher false alarm rates for positive items shows that participants were biased such that they were more likely to respond that the positive stimuli were present. Finally, there is also an interaction of valence and modality showing that participants were more biased in responding to positive stimulus if the stimulus was a verbal item.

An interesting effect of valence on overall recognition accuracy was found such that positive items were recognized less compared to neutral and negative items across different age groups and different modality of presentations. This effect was the opposite of the previous studies; so as the finding that there was no age and valence interaction. Young and old adults both showed less accuracy in recognizing positive valence items. Contrary to our finding, Cartensen & Mikels (2005), state in socioemotional selectivity theory that there is a positivity effect which is present in long-term memory, leading old adults to remember positive items better. There are two possible explanations to

[12]A participant may be more likely to respond that a stimulus is present or more likely to respond that a stimulus is not present.

justify the difference in our findings. First, the reversed positivity effect that we found may be due to the effect of valence when arousal is constrained to neutral values. The evidence that support the positivity effect in the aging population of Cartensen & Mikels (2005) was found for stimuli containing high and low variations both in valence and arousal axes of emotion. The stimuli used in those experiments were not controlled for arousal. However in our study, we specifically investigated the effect of valence by varying the valence values of stimuli between negative, neutral and positive, while restricting the values for arousal to neutral. It may well be that arousal is an essential component for enhanced recognition of positive items, whereas valence contributes to the recognition of negative items along with arousal. Especially when the neuroscience perspective is considered, if the amygdala is the main modulator of memory for emotional items, then it is expected that the amygdala's effect will be observed prominently for items that contain high arousal; because the amygdala is a key player in the arousal circuitry of the limbic system. Hence, memory enhancement may not be observed for stimuli for which the arousal dimension is controlled.

Second, another factor contributing to the observation of significantly lower accuracy in positive items for older adults could be cultural differences. According to Gutchess et al (2006), culture and age interact to influence cognition. In a free recall memory experiment done with East-Asian young and old adults versus American young and old adults, the findings showed that East-Asian participants used different strategies than American participants did, although the overall performance was similar for both ethnic groups. Specifically, young and elderly groups from Chinese and American cultures were compared in encoding words presented in their native language. The participants were presented two lists, one containing categorically unrelated words and the other containing categorically related words. Cultural differences were observed for the elderly, with East-Asians using categories less than Americans during recall of categorically related words. These studies conveyed a cultural bias, which was distinctively higher for elderly adults. This

is evidence for the likelihood that such a cultural bias could have played a role in our thesis. Previous emotion memory studies were carried out on Western samples only, and consequently, the positivity effect in recognition memory was observed in Western cultures only. However, our study was conducted in a non-Western culture. Therefore, the reversal of the positivity effect observed in our study might be due to cultural effects associated with our sample. It could be that there is an overall negativity effect present in the Turkish culture. This could be further investigated by carrying out mood questionnaires prior to the experiments.

4.1.4 Aging effects on recognition memory

Analysis on ‘remember/know’ judgments revealed that the process of familiarity was affected from the differences in age. Younger adults tend to use familiarity more in recognizing old items compared to elderly adults. These findings were inconsistent with the literature. Ochsner (2000), Kensinger and Corkin (2004), Sharot et al. (2004) failed to find a valence effect on the familiarity process. This inconsistency may be due to the ‘remember/know’ judgments. Although the instructions regarding these judgments were especially stressed, the difference between these two judgments might not have been clearly understood in essence.

In order to overcome the limitations introduced by 'remember/know' judgments, further analysis was conducted using signal detection theory. ‘Remember’ and ‘Know’ responses were both considered as old judgments and used for computing the old judgment proportions, such as hit rates and false alarm rates (Wixted, 2004). Then using hits and false alarm rates, recognition accuracy, d', was computed from the signal detection theory. This measure represented how accurate were the participants in discriminating old items from new ones. The results showed that age differences had an effect on recognition accuracy. More specifically, young adults recognized more accurately compared to old adults. This finding is consistent with the literature that there are age differences in recognition memory (Grady, 2000).

Further analysis on recognition accuracy revealed that hit rates did not change with respect to the manipulations of emotional valence and the differences in age. The analysis on false alarm rates showed that old adults had more false alarms than young adults did. In other words, young and old adults had similar hit rates but old adults had greater false alarm rates. Therefore, the reduction in overall accuracy in the aging population is due to the assignment of 'old' responses to new items by this population. This is consistent with previous literature in this area. Isingrini et al. (1995) carried out a word-pair recognition study to probe encoding deficits related to aging. They found that older participants produced significantly more false alarms to distracters related to target items than the young participants but that they did not differ in their false alarm rate for unrelated distracters. This finding supported their hypothesis that aging brings out an insufficiency in elaborate or distinctive encoding. Furthermore, their data showed an increase in all false alarms rates with later aging, suggesting that the encoding deficit gets worse in late adulthood.

The reaction times data showed a different pattern under aging. As expected from the hit rates analysis, reaction times of hits did not differ significantly and as expected for false alarm rates, the reaction times differed with respect to age. Also, contrary to higher false alarm rates for verbal items compared to visual items, the reaction times of verbal items were lower than that of visual items only for older adults. This finding shows that older adults gave more wrong answers for verbal stimuli in a faster way -perhaps with more confidence- than they did for visual stimuli. The reason for this behavior might have been that older adults were guessing in verbal recognition task. Regarding the overall recognition accuracy of verbal task, which is $d' = 0.79$, the idea that old adults might have guessed in verbal task should also be considered.

4.1.5 Valence, age, abstractness/concreteness effects in verbal recognition memory

Further analysis on verbal recognition memory was conducted in order to observe how abstractness and concreteness affected the decisions of 'old' and 'new'. Data showed that, consistent with previous analysis, younger adults were able to recognize words more accurately than older adults did. Inconsistent with the previous analysis of overall recognition accuracy which had pooled data together from both modalities, for words alone, there was a significant interaction of valence and age. More specifically, older adults were significantly less accurate in words with positive valence. This difference might have arisen from using the signal detection statistics in estimating recognition accuracy for abstract and concrete words. As stated in the limitations section below, within the scope of this thesis, verbal stimuli were not selected to control abstractness/concreteness. The reason for this is because studying differences across abstractness and concreteness was not one of the goals of our study at the beginning. Thus, although both abstract and concrete words were distributed similarly across 'old' and 'new' items, the proportion of concrete words were higher compared to abstract words (66 % concrete, 34% abstract). Therefore, the variations in d' were higher in the abstractness analysis than in the overall recognition accuracy.

The analysis of concrete words showed that there was an effect of age and an effect of valence within the concrete words. Young adults were more accurate in recognizing concrete words as compared to elderly adults. Negative concrete words were more accurately recognized in both age groups. On the other hand, the data of abstract words showed that, unlike older adults, young adults were more accurate when the words were positive. Older adults were similarly accurate in negative words as younger adults; however, the accuracy in recognizing neutral and positive valence abstract words reduced in the aged population compared to younger adults. The level of reduction was highest in positive abstract words. These effects are very interesting byproducts of our study. At this point we believe that elaborating beyond these results would be

highly speculative. A separate experimental setting with controlled variables should be created to observe these effects in a more systematic manner.

4.2 LIMITATIONS

4.2.1 General experimental choices

MERT was used to rate words in three dimensions; arousal, valence and dominance. The face figures employed in MERT have not been tested for ecological validity in reflecting the associated values of valence, arousal and dominance. Thus, although there is a significant correlation between the mean ratings collected by using MERT and the mean ratings collected by using SAM, a test for ecological validity could be considered for further studies involving MERT.

As stated previously, in recognition memory tasks, the instructions for "remember" and "know" judgments may not be well understood by all subjects. In the future, the experimenter could make sure that participants understood the instructions correctly by asking them to rephrase what they have understood from the task.

In order to report the mental healthiness of the older adult participants, Minimental State Examination was used. Minimental State Examination might not be adequate enough to indicate the level of dementia, if there is any. Thus, for the aging population, additional psychometric batteries could be included.

4.2.2 Verbal recognition memory

It is shown that the semantic relatedness of items in the positive valence category is a confounding factor in verbal recognition memory. Maratos et al. (2000) found emotion reduced recognition accuracy when the emotional words were semantically inter-related than neutral words. Dougal and Rotello (in press) also replicated this finding such that memory for neutral items was

enhanced compared to emotional items, when semantic inter-relatedness was not controlled. In our findings, semantic inter-relatedness is probably not an important factor because of two reasons: First, we found similar results of reduced recognition for positive valence in both words and pictures. Second, there is reduced recognition of neutral words although obviously, the semantic inter-relatedness of neutral words is low. Still, a future study can be beneficial to investigate the semantic inter-relatedness of the words in our verbal stimulus set.

The words used in this study were selected specifically on the basis of valence ratings, therefore, the pool which was constructed in Experiment 1 was limited. Thus, the frequency of words of such a limited pool could not be controlled due to scarce word frequency quantifications in Turkish. If future studies are intended to investigate the effect of frequency in a verbal recognition task, a new verbal stimulus set should be constructed which also takes the frequencies of words into account.

In verbal recognition memory, abstractness and concreteness analysis was conducted as an extra study, which was not intended at the beginning. Thus the abstractness and concreteness of words is not controlled fully in this study. There were 66% of concrete words and 34% of abstract words in the experiment. In order to observe the effect of variations in abstractness more accurately, another study can be initiated in the future in which the distribution of abstract and concrete words are controlled, preferably by using a continuous scale of classification that varies from abstract to concrete.

CHAPTER 5

CONCLUSION

The present study investigated the effects of aging and valence on verbal and visual recognition memory. In order to observe the effect of valence in a systematic way, arousal was controlled by selecting words and pictures with neutral arousal while different levels of valence (negative, neutral and positive) are utilized. This allowed comparing the effect of valence in both modalities; visual and verbal. Most importantly, age related changes in recognition memory were also investigated in relation to valence and modality. The results demonstrated differences between young and old adults with respect to recognition memory, as well as how differences in valence and modality affected recognition memory.

Prior to recognition memory experiments, METU Turkish Emotional Words (METU – TEW) which is a standardized material of emotional ratings for Turkish words, was initiated in order to select words for the recognition memory experiment. Previously, normative emotional ratings for a set of Turkish words were not available for public use to researchers in study of emotion. Therefore, developing methods to create METU–TEW has been one of the significant contributions of this study. Another byproduct of this thesis was, MERT (Manikins for Emotional RaTing); a user friendly graphical illustration to be used for rating words in three emotional dimensions; valence, arousal and dominance. MERT can be used in future emotion studies to rate materials other than words; for example, pictures and sounds.

Our recognition memory experiment produced two anticipated results. First, we were able to replicate the previous findings that elderly adults were less accurate in both verbal and visual recognition memory regardless of emotional differences in items. Second, as expected, recognition accuracy for visual items is higher compared to verbal items regardless of valence. Age difference also supports this picture-superiority effect.

Our recognition memory study has produced two main findings. First of all, contrary to the previously reported positivity effect in older adults, positive stimuli were less accurately recognized in our experiments. We speculate that controlled arousal and cultural differences may explain the occurrence of this reverse positivity effect. Obviously, further studies are needed to observe whether cultural differences affect processes of emotion and aging. On the other hand, in order to understand the contribution of arousal to the positivity effect, another experiment, in which valence is set to neutral and arousal is varied should be conducted. Consequently, it can be shown whether the positivity affect is actually confined to arousal.

Secondly, further analysis on verbal recognition memory regarding the abstractness and concreteness of words, revealed a significant finding that the recognition of abstract words was affected by valence and aging. However, this result may not be sufficient to conclude an effect on recognition memory regarding valence and aging, because abstractness and concreteness were not equally distributed across our verbal stimuli to check for their effects. Thus, a further study is needed to observe the effect of abstractness or concreteness in verbal recognition memory more precisely in a controlled experiment.

To summarize, we can say that this thesis focused on the interaction of three highly complex processes: memory, emotion and aging. As a result of the experiments performed within the scope of this study, we were able to replicate some earlier studies and draw some new conclusions as follows: Healthy aging

processes have a profound effect on recognition memory, and visual modalities are facilitated more in recognition memory in comparison to verbal modalities. Our results imply that for a sample of subjects chosen from the Turkish population, recognition memory behaves contrary to expectations regarding the effects of the valence dimension of emotion. Specifically, it seems that positive memory items are not recognized as well as negative and neutral memory items. It is a possibility that memory processes operate differently on the dimension with varied abstractness and concreteness, because we also found that valence and age have differential effects in the recognition of abstract versus concrete verbal stimuli.

REFERENCES

Atkinson, R. C., and Juola, J. F. (1974). Search and decision processes in recognition memory. In D. H. Krantz, R. C. Atkinson, R. D. Luce, & P. Suppes (Eds.), *Contemporary developments in mathematical psychology, Vol. 1: Learning, memory & thinking*. San Francisco: Freeman.

Bradley, M.M., and Lang, P.J. (1999). *Affective norms for English words (ANEW): Stimuli, instruction manual and affective ratings. Technical report C-1*. Gainesville, FL. The Center for Research in Psychophysiology, University of Florida.

Cabeza, R. (1997) Age-related differences in neural activity during memory encoding and retrieval: a positron emission tomography study. *Journal of Neuroscience, 17,* 391-400.

Cahill, L.F. and McGaugh, J.L.(1998). Mechanisms of emotional arousal and lasting declarative memory. *Trends in Neurosciences, 21,* 294-299.

Canli, T., Zhao, Z., Brewer, J., Gabrieli, J.D.E., and Cahill, L. (2000). Activation in the human amygdala associates event-related arousal with later memory for individual emotional experience. *The Journal of Neuroscience, 20,* 1-5.

Carstensen, L.L. and Mikels, J.A. (2005). At the intersection of emotion and cognition: Aging and the positivity effect. *Current Directions in Psychological Science, 14,* 117-121.

Cato, A.M., Crosson, B. and Gökçay, D. (2004). Processing words with emotional connotation: an fMRI study of time course and laterality in rostral

frontal and retrosplenial cortices. *Journal of Cognitive Neuroscience, 16,* 167–177.

Charles, S. T., Mather, M., and Carstensen, L. L. (2003). Aging and emotional memory: The forgettable nature of negative images for older adults. *Journal of Experimental Psychology: General, 132,* 310-324.

Craik, F. I. M., & Lockhart, R. S. (1972). Levels of Processing: a framework for memory research. *Journal of Verbal Learning and Verbal Behavior, 11*, 671-684.

Donaldson, W. (1996). The role of decision processes in remembering and knowing. *Memory & Cognition, 24,* 523-533.

Dougal, S., and Rotello, C.M. (in press). "Remembering" emotional words is based on response bias, not recollection. *Psychonomic Bulletin & Review*.

Eichenbaum, H., Otto, T., and Cohen, N.J. (1994). Two functional components of the hippocampal memory system. *Behavioral and Brain Sciences, 17*, 449-517.

Gardiner, J.M. (1988). Functional aspects of recollective experience. *Memory & Cognition, 16,* 309-313.

Gardiner, J. M., and Parkin, A. J. (1990). Attention and recollective experience in recognition memory. *Memory & Cognition, 18,* 579–583.

Grady, C. L. (2000). Functional brain imaging and age-related changes in cognition. *Biological Psychology, 54*, 259-281.

Grady, C. L., and Craik F. I. M. (2000). Changes in memory processing with age. *Current Opinion in Neurobiology, 10,* 224-231.

Green, D. M., and Swets, J. A. (1966). *Signal detection theory and psychophysics.* New York: John Wiley and Sons.

Gross, J.J. (1998). The emerging field of emotion regulation: an integrative review. *Review of General Psychology, 2,* 271--299.

Gutchess, A.H., Yoon, C., Luo, T., Feinberg, F., Hedden, T., Jing, Q., Nisbett, R.E. & Park, D.C. (2006). Categorical organization in free recall across culture and age. *Gerontology, 52,* 314-323.

Güngen, C., Ertan, T., Eker, E., Yaşar, R., and Engin, F. (2002). Standardize Mini Mental Test'in Türk Toplumunda Hafif Demans Tanısıda Geçerlik ve Güvenilirliği. *Türk Psikiyatri Dergisi, 13,* 273-281.

Hamann, S. (2001). Cognitive and neural mechanisms of emotional memory. *Trends in Cognitive Sciences, 5,* 394-400.

Hay, J. F., and Jacoby, L. L. (1996). Separating habit and recollection: Memory slips, process dissociations and probability matching. *Journal of Experimental Psychology: Learning, Memory and Cognition, 22,* 1323-1335.

Howard, M. W., Bessette-Symons, B. A., Zhang, Y., and Hoyer, W. J. (2006). Aging selectively impairs recollection in recognition memory for pictures: Evidence from modeling and ROC curves. *Psychology and Aging, 21,* 96–106.

Isingrini M., Fontaine R., Taconnat L., and Duportal A. (1995). Aging and encoding in memory: false alarms and decision criteria in a word-pair recognition task. *International Journal of Aging & Human Development, 41,* 79-88.

Jacoby, L. L. (1991). A process dissociation framework: Separating automatic from intentional uses of memory. *Journal of Memory and Language, 30,* 513-541.

Kensinger, E.A., and Corkin, S. (2003). Memory enhancement for emotional words: Are emotional words more vividly remembered than neutral words? *Memory and Cognition, 31,* 1169-1180.

Kensinger E.A, Piguet O, Krendl AC, and Corkin S (2005). Memory for contextual details: Effects of emotion and aging. *Psychology and Aging, 20,* 241-250.

LaBar, K. S. and Cabeza, R. (2006). Cognitive neuroscience of emotional memory. *Nature Neuroscience Reviews, 7,* 54-64.

Lang, P.J. (1980). Behavioral treatment and bio-behavioral assessment: Computer applications. In J. B. Sidowski, J. H. Johnson, & T. A. Williams (Eds.), *Technology in mental health care delivery systems* (pp. 119-137). Norwood, NJ: Ablex Publishing.

Lang, P.J., Bradley, M.M., and Cuthbert, B.N. (2005). *International affective picture system (IAPS): Affective ratings of pictures and instruction manual. Technical Report A-6*. University of Florida, Gainesville, FL.

Mandler, G. (1980). Recognizing: The judgment of prior occurrence. *Psychological Review, 87,* 252-271.

Maratos, E., Allan, K., and Rugg, M. D. (2000). Recognition memory for emotionally negative and neutral words: An ERP study. *Neurospychologia, 38,* 1452–1465.

Mather, M., & Carstensen, L.L. (2003). Aging and attentional biases for emotional faces. *Psychological Science, 14,* 409–415.

Mather, M., Canli, T., English, T., Whitfield, S., Wais, P., Ochsner, K., Gabrieli, J., and Cartensen, L. (2004). Amygdala responses to Emotionally Valenced Stimuli in Older and Younger adults. *Psychological Science, 15,* 259-263.

Nadel, L. (1992). Multiple memory systems: What and why. *Journal of Cognitive Neuroscience, 4,* 179–188.

Nyberg, L., Cabeza, R., and Tulving, E. (1998). Asymmetric frontal activation during episodic memory: What kind of specificity? *Trends in Cognitive Sciences, 2,* 419–410.

Ochsner, K. N. (2000). Are affective events richly recollected or simply familiar? The experience and process of recognizing feelings past. *Journal of Experimental Psychology: General, 129,* 242-261.

Osgood, C.E., Suci, G.J., and Tannenbaum, P.H. (1957) *The measurement of meaning.* Urbana: University of Illinois Press.

Paivio, A. (1971). *Imagery and verbal processes.* New York: Holt, Rinehart & Winston.

Park, D.C. and Gutchess, A. (2006). The cognitive neuroscience of aging and culture. *Current Directions in Psychological Science, 15*, 105-108.

Phelps, E.A. (2004). Human emotion and memory: Interactions of the amygdala and hippocampal complex. *Current Opinion in Neurobiology, 14,* 198-202.

Phelps, E.A. (2006). Emotion and cognition: Insights from studies of the human amygdala. *Annual Review of Psychology, 57,* 27-53.

Rajaram, S. (1993). Remembering and knowing: Two means of access to the personal past. *Memory & Cognition, 21*, 89-102.

Salthouse, T. A. (1996). The processing–speed theory of adult age differences in cognition. *Psychological Review, 103,* 403–428.

Sharot, T., Delgado, M.R., Phelps, E.A. (2004). How emotion enhances the feeling of remembering. *Nature Neuroscience, 7,* 1376-1380.

Squire, L. R., Knowlton, B., and Musen, G. (1993). The structure and organization of memory. *Annual Review of Psychology, 44*, 453-495.

Stretch, V., and Wixted, J. T. (1998). On the difference between strength-based and frequency-based mirror effects in recognition memory. *Journal of Experimental Psychology: Learning, Memory & Cognition, 24*, 1379-1396.

Thomas, R.C. (2006). The Influence of Emotional Valence on Age Differences in Early Processing and Memory. The Influence of Emotional Valence on Age

Differences in Early Processing and Memory. *Psychology and Aging, 21,* 821–825.

Tucker, D. M., Derryberry, D., and Luu, P. (2000). Anatomy and physiology of human emotion: Vertical integration of Brainstem, Limbic and Cortical systems. In J. Borod (Ed.), *Handbook of the neuropsychology of emotion* (pp. 56-79). London: Oxford University Press.

Tulving, E. (1983). *Elements of Episodic Memory*. New York: Oxford University Press.

Tulving, E. (1985). Memory and consciousness. *Canadian Psychology, 26,* 1-12.

Verhaeghen, P., and Cerella, J. (2002). Aging, executive control, and attention: A review of meta-analyses. *Neuroscience and Biobehavioral Reviews, 26,* 849-857.

Verschuere, B., Crombez, G., & Koster, E. (2001). The International Affective picture system: a Flemish validation study. *Psychologica Belgica, 41,* 205-217.

Wixted, J. T. and Stretch, V. (2004). In defense of the signal-detection interpretation of Remember/Know judgments. *Psychonomic Bulletin & Review, 11,* 616-641.

Wixted, J. T. (2007). Dual-process theory and signal-detection theory of recognition memory. *Psychological Review, 114,* 152-176.

Yonelinas, A.P. (1994). Receiver operating characteristics in recognition memory: Evidence for a dual process model. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20,* 1341-1354.

Yonelinas, A.P. and Jacoby, L.L. (1995). The relation between remembering and knowing as bases for recognition: Effects of size congruency. *Journal of Memory and Language, 34,* 622-643.

Yonelinas, A.P., Dobbins, I., Szymanski, M.D., Dhaliwal, H.S., and Kink, L. (1996). Signal detection, threshold, and dual process models of recognition memory: ROCs and conscious recollection. *Consciousness and Cognition, 5,* 418-441.

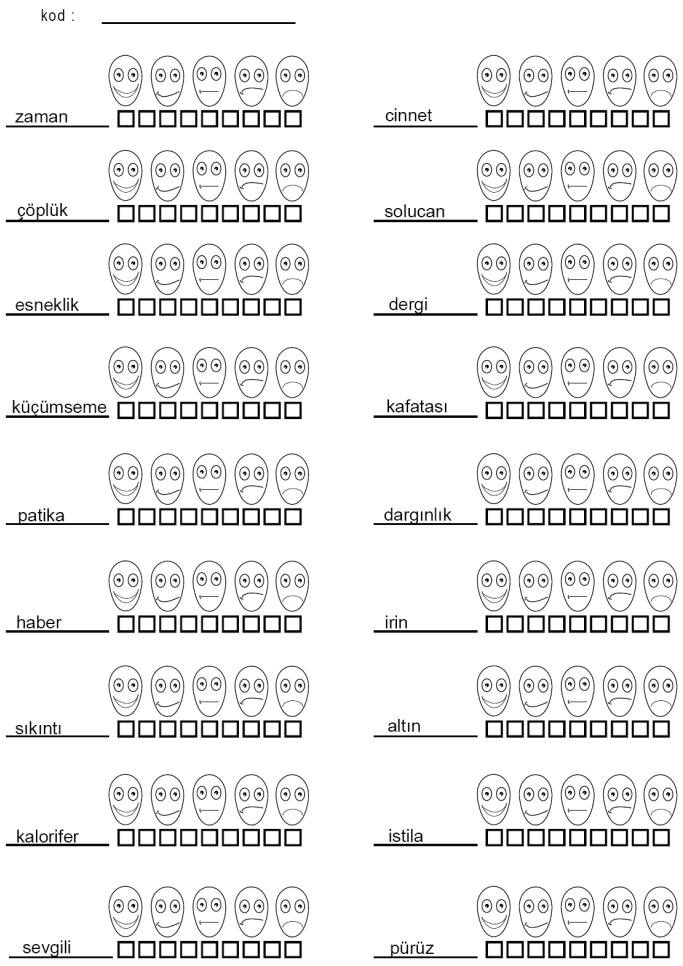
Yonelinas, A.P. (1997). Recognition memory ROCs for item and associative information: The contribution of recollection and familiarity. *Memory and Cognition, 25*, 747-763.

Yonelinas. A.P. (2002). The nature of recollection and familiarity: A review of 30 years of research. *Journal of Memory and Language, 46*, 441-517.

APPENDICES

APPENDIX A : MANIKIN OF EMOTIONAL RATING

Valence (Sample Page)



Arousal (Sample Page)

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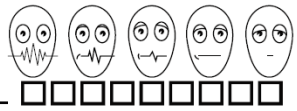
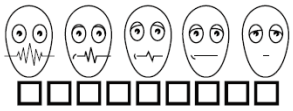
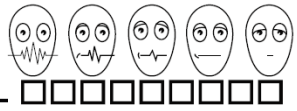
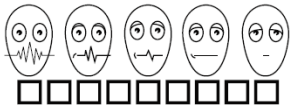
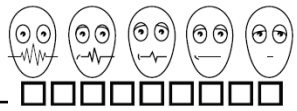
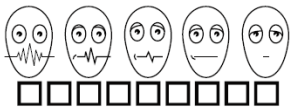
doktor 

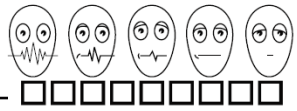
yara 

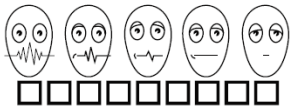
raslantı 

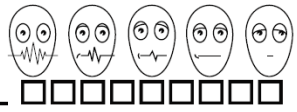
doğa 

vücut 

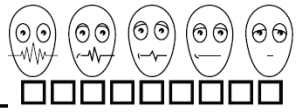
ıslık 

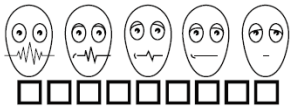
çarşı 

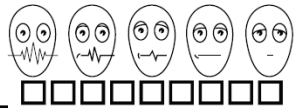
tanrı 

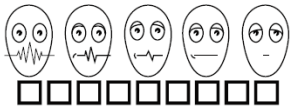
garez 

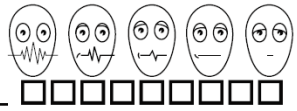
yatırım 

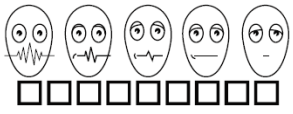
kaya 

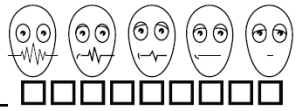
hain 

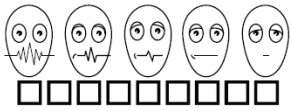
saldırı 

çekiç 

sirk 

mahzen 

melek 

çamur 

Dominance (Sample Page)

kod : _____

rüşvet 

sükunet 

taciz 

durum 

gökkuşağı 

şefkat 

egoizm 

kibir 

teori 

uyuşturucu 

araç 

sinema 

sataşma 

ihmal 

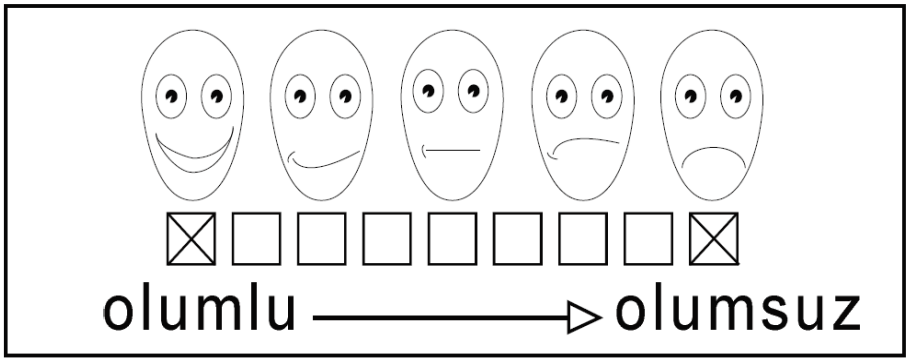
ilgi 

güzellik 

dehşet 

zarar 

Valence Instructions

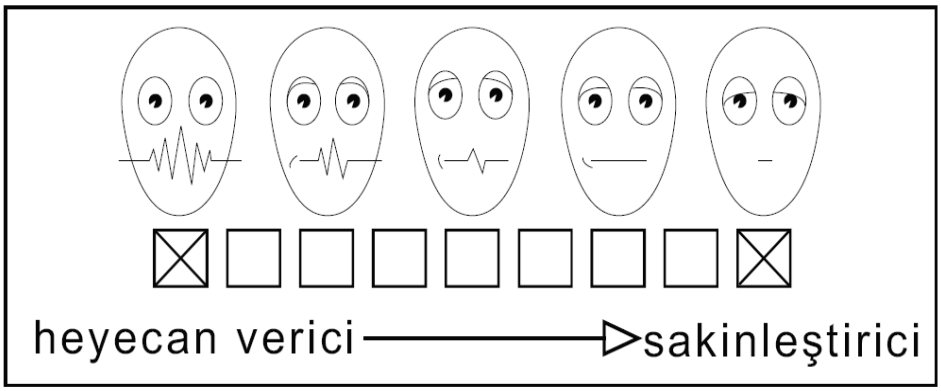


Deneye katıldığınız için teşekkürler. Bugün yapacağımız çalışma duygularla ilgili ve bu çalışmada insanların farklı tip kelimelere nasıl tepki verdiğiyle ilgileniyoruz. Önünüzde çeşitli figürler içeren kağıtlar var. Bu figürlere "Değerlendirme Yüzleri" diyoruz ve sizden istediğimiz bu figürleri kullanarak her bir kelimenin sizde uyandırdığı etkiyi derecelendirmek. Bu yüzler üç farklı duygu sınıfını ve bu sınıf içerisindeki dereceleri göstermekte.

Yukarıdaki ölçek gülümseyen adamdan mutsuz adama sıralanmış olumlu-olumsuz ölçeğidir. Bu ölçeğin sol ucu, kelimeyi değerlendirdiğinizde mutlu, hoşnut, tatmin olmuş ve umutlu hissettiğinizi gösterir. Kendinizi çok mutlu hissettiğinizde, bunu en soldaki kareyi işaretleyerek belirtiniz. Ölçeğin sağ ucu ise, kelimeyi değerlendirdiğinizde kendinizi mutsuz, kızgın, umutsuz, kederli ve sıkıntılı hissettiğinizi gösterir. Çok mutsuz hissettiğiniz durumu, en sağdaki kareyi işaretleyerek gösteriniz. Aradaki kareleri de daha az mutlu veya mutsuz hissettiğinizi belirtmek için kullanabilirsiniz. Eğer tamamıyla nötr hissediyorsanız, yani mutlu ya da mutsuz hissetmiyorsanız, en ortadaki kareyi işaretlemeniz gerekir. Ne kadar mutlu veya mutsuz hissettiğinizi en iyi şekilde belirtmek için toplam olası 9 kareden o kelimeye karşı hislerinizi gösteren en uygun kareyi işaretleyiniz.

Lütfen her kelime için çok fazla düşünmeden, değerlendirmeyi hızlı yapmaya çalışınız. Hatta değerlendirmelerinizi kelimeyi ilk görüşünüzdeki tepkinize dayanarak yapınız. Kelimeler arasında herhangi bir ilişki yoktur. Bu nedenle her kelimenin bağımsız olarak değerlendirilmesi gerekmektedir. Örneğin, tesadüfen peş peşe hep benzer kareyi işaretlediyseniz, sırf bu yüzden bundan sonraki işaretleyişlerinizi değiştirmeyin.
Teşekkürler.

AROUSAL INSTRUCTIONS

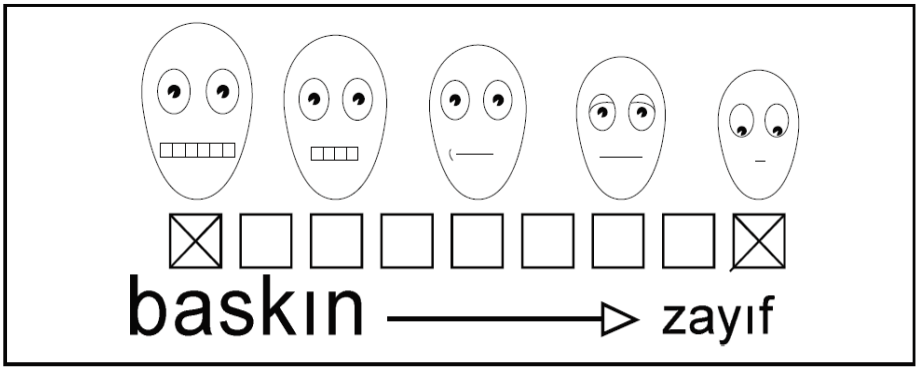


Deneye katıldığınız için teşekkürler. Bugün yapacağımız çalışma duygularla ilgili ve bu çalışmada insanların farklı tip kelimelere nasıl tepki verdiğiyle ilgileniyoruz. Önünüzde çeşitli figürler içeren kağıtlar var. Bu figürlere "Değerlendirme Yüzleri" diyoruz ve sizden istediğimiz bu figürleri kullanarak her bir kelimenin sizde uyandırdığı etkiyi derecelendirmek. Bu yüzler üç farklı duygu sınıfından birinin içerisindeki dereceleri göstermekte.

Yukarıdaki ölçek heyecanlı adamdan sakin adama sıralanmış heyecan verici - sakinleştirici ölçeğidir. Bu ölçeğin sol ucu, kelimeyi değerlendirdiğinizde heyecanlı, coşkun, sinirli, tetikte veya canlı hissettiğinizi gösterir. Eğer heyecanlanmış hissediyorsanız, en soldaki kareyi işaretlemeniz gerekir. Bu ölçeğin sağ ucuna baktığınızda, tam tersi olan sakin yüz şeklini göreceksiniz. Kendinizi kelimeyi değerlendirirken tamamen rahatlamış, sakin, ağır, durgun hissettiğinizde en sağdaki kareyi işaretlemeniz gerekir. Heyecanlı ve sakin hisler arasındaki hislerinizi ortadaki karelerden birini işaretleyerek belirtebilirsiniz. Eğer tamamıyla nötr hissediyorsanız, yani heyecanlı ya da sakin hissetmiyorsanız, en ortadaki kareyi işaretleyiniz. Ne kadar heyecanlı veya sakin hissettiğinizi en iyi şekilde belirtmek için toplam 9 kareden o kelimeye karşı hislerinizi gösteren en uygun kareyi işaretleyiniz.

Lütfen her kelime için çok fazla düşünmeden, değerlendirmeyi hızlı yapmaya çalışınız. Hatta değerlendirmelerinizi kelimeyi ilk görüşünüzdeki tepkinize dayanarak yapınız. Kelimeler arasında herhangi bir ilişki yoktur. Bu nedenle her kelimenin bağımsız olarak değerlendirilmesi gerekmektedir. Örneğin, tesadüfen peş peşe hep benzer kareyi işaretlediyseniz, sırf bu yüzden bundan sonraki işaretleyişlerinizi değiştirmeyin.
Teşekkürler.

DOMINANCE INSTRUCTIONS



Deneye katıldığınız için teşekkürler. Bugün yapacağımız çalışma duygularla ilgili ve bu çalışmada insanların farklı tip kelimelere nasıl tepki verdiğiyle ilgileniyoruz. Önünüzde çeşitli figürler içeren kağıtlar var. Bu figürlere "Değerlendirme Yüzleri" diyoruz ve sizden istediğimiz bu figürleri kullanarak her bir kelimenin sizde uyandırdığı etkiyi derecelendirmek. Bu yüzler üç farklı duygu sınıfından birinin içerisindeki dereceleri göstermekte.

Yukarıdaki ölçek kendinizi baskın-zayıf olarak değerlendireceğiniz ölçektir. Ölçekteki figürün büyük olması sizin kelimeyi değerlendirirken baskın hissetiğinizi, küçük olması da zayıf hissetiğinizi gösterir. Eğer kontrolün tamamen sizde olduğunu düşünüyorsanız, etkin, önemli, baskın, özerk veya kontrollü hissediyorsanız, en soldaki kareyi işaretleyiniz. Bu ölçeğin sağ ucu ise, kelimeyi değerlendirirken kendinizi tamamıyla kontrol edilen, etki altında, himaye altına alınmış, korkutulmuş, boyun eğmiş, baskı altına alınmış veya güçsüz hissettiğinizi gösterir. Aradaki kareleri de daha az baskın veya zayıf hissettiğinizi belirtmek için kullanabilirsiniz. Eğer tamamıyla nötr hissediyorsanız, yani baskın ya da güçsüz hissetmiyorsanız, en ortadaki kareyi işaretlemeniz gerekir. Kelimeye karşı hislerinizi en iyi şekilde belirtmek için toplam 9 kareden en uygun olanı işaretleyiniz.

Lütfen her kelime için çok fazla düşünmeden, değerlendirmeyi hızlı yapmaya çalışınız. Hatta değerlendirmelerinizi kelimeyi ilk görüşünüzdeki tepkinize dayanarak yapınız. Kelimeler arasında herhangi bir ilişki yoktur. Bu nedenle her kelimenin bağımsız olarak değerlendirilmesi gerekmektedir. Örneğin, tesadüfen peş peşe hep benzer kareyi işaretlediyseniz, sırf bu yüzden bundan sonraki işaretleyişlerinizi değiştirmeyin.
Teşekkürler.

APPENDIX B: AFFECTIVE NORMS FOR TURKISH WORDS

Table 6 Affective norms for Turkish words

Kelime	VAL MN	VAL STDV	AR MN	AR STDV	DOM MN	DOM STDV
abes	3,889	1,352	5,311	1,856	4,667	1,771
ağırlama	6,667	1,398	5,156	2,266	6,733	1,802
aile	7,911	1,311	3,711	2,625	6,511	2,342
alet	5,977	1,635	4,956	1,445	5,733	1,684
altın	6,956	1,930	6,200	2,007	5,578	1,901
ampül	6,795	1,760	5,489	1,632	5,622	1,709
angarya	2,689	1,690	5,444	1,937	4,778	2,099
anlam	6,333	1,365	5,156	2,110	5,889	1,735
araç	6,511	1,561	5,267	1,763	5,773	1,583
asansör	5,356	1,583	5,022	1,764	5,200	1,590
ay	7,422	1,454	4,911	2,770	4,844	2,163
ayrıntı	6,622	1,614	5,644	2,002	5,978	2,083
ayyaş	2,867	1,804	5,711	2,052	4,800	2,052
bagaj	5,022	1,340	5,068	1,822	5,244	1,540
balçık	3,444	1,501	5,244	1,734	4,156	1,580
batak	2,800	1,902	6,022	2,039	3,978	2,039
bataklık	2,756	1,626	5,778	2,163	3,800	1,866
bela	2,341	1,509	6,889	1,861	3,956	2,522
bilek	5,400	1,136	4,795	1,720	5,622	1,284
bombardıman	1,756	1,417	7,756	1,747	3,044	2,558
borozan	4,889	1,933	5,356	1,824	5,133	1,878
boya	5,933	1,543	4,911	1,579	5,267	1,421
buzluk	5,467	1,424	4,622	1,980	5,000	1,732
buzul	5,222	2,235	4,644	1,932	4,444	1,865
cadde	5,578	1,602	5,022	1,764	5,356	1,721
cam	6,200	1,502	4,889	2,069	5,400	1,711
çamur	4,044	1,858	4,978	1,790	5,156	1,692
çarşı	6,711	1,727	6,444	1,803	6,156	1,796
cehalet	1,756	1,300	6,178	2,396	4,333	3,000
çekiç	4,733	1,321	5,378	1,556	5,750	1,819
çiçek	7,756	1,334	4,311	2,678	5,578	2,251
ciddiyet	5,822	1,542	4,933	1,993	6,289	2,030
çimen	7,667	1,414	5,000	2,523	6,000	1,895
çıngırak	4,467	2,085	5,444	2,190	4,667	2,034
cinnet	2,044	1,637	7,378	1,825	3,689	2,610
cinsiyet	5,511	1,290	5,156	1,242	5,356	2,155
civciv	6,956	1,718	4,822	2,443	5,467	1,727
çöplük	2,533	1,455	5,578	1,994	4,311	1,869
dargınlık	2,756	1,448	5,933	2,209	4,311	2,476
davranış	6,111	1,283	5,133	1,791	6,489	2,232

Table 6 (continued)

Kelime	VAL MN	VAL STDV	AR MN	AR STDV	DOM MN	DOM STDV
değnek	4,533	1,517	4,756	1,209	4,705	1,456
dehşet	2,511	2,007	7,956	1,595	4,333	2,747
demir	5,178	1,072	5,000	1,492	5,222	1,428
depo	5,289	1,180	4,511	1,456	4,622	1,386
dergi	6,911	1,411	4,756	2,013	5,822	1,723
dert	2,556	1,486	5,778	2,204	4,295	2,184
dilenci	2,756	1,540	5,556	2,117	4,727	1,969
doğa	8,400	1,009	5,133	3,050	5,333	2,585
doktor	5,778	2,033	6,311	2,076	3,956	2,662
domuz	3,578	1,764	5,556	1,937	4,356	1,836
dostluk	8,178	1,614	5,711	2,997	7,156	2,099
düğüm	4,689	1,564	5,089	1,703	5,178	1,992
durum	5,511	1,180	4,511	1,487	5,378	1,800
duygu	6,933	1,657	6,089	2,720	6,867	1,829
egoizm	3,022	1,840	5,864	2,064	4,200	2,436
el	6,689	1,427	5,333	1,846	6,089	1,832
elmas	7,000	2,174	6,778	1,941	5,711	1,938
eroin	1,756	1,640	7,111	2,298	4,444	3,027
eşcinsellik	3,333	1,977	5,422	2,369	4,356	2,101
esneklik	6,622	1,838	4,711	2,181	5,822	2,015
etki	5,644	1,401	5,556	1,803	5,956	1,858
fahişe	3,867	2,272	6,200	2,180	4,222	2,055
fener	6,178	1,800	4,756	2,002	5,089	1,844
fesat	2,311	1,756	6,644	1,734	4,511	2,390
fırın	6,067	1,421	5,067	1,839	5,356	1,317
fırtına	4,356	1,990	7,311	1,411	4,444	2,563
frengi	1,889	1,695	6,489	2,191	3,489	2,390
garez	2,156	1,348	7,089	1,490	4,533	1,961
gazyağı	4,400	1,587	5,133	1,408	4,622	1,248
gelenek	5,400	2,104	4,889	2,091	4,591	2,326
gemi	7,044	1,783	5,356	2,479	5,578	1,877
gökdelen	5,644	1,897	6,200	2,063	5,267	2,230
gökkuşağı	8,044	1,381	5,578	3,019	5,289	2,625
gölge	5,622	1,600	4,400	1,876	4,911	1,929
gübre	3,844	2,132	5,578	1,751	4,600	1,839
gülümseme	8,289	1,254	5,400	3,194	7,267	1,993
gün doğumu	7,889	1,526	5,200	3,174	6,111	2,596
günbatımı	6,909	2,055	4,978	2,701	5,222	2,610
güzellik	8,111	1,172	6,178	2,894	6,244	2,404
haber	6,111	1,668	6,244	2,176	5,467	1,575
hain	1,978	1,422	7,356	1,612	4,444	2,351
hamamböceği	2,489	1,590	6,578	2,028	3,667	2,023
hapishane	1,800	1,408	6,622	2,358	3,378	2,733
harabe	4,467	2,018	5,800	1,961	4,889	1,980
hareket	6,818	1,559	6,533	2,074	7,067	1,935
harf	5,667	1,492	4,889	1,933	5,622	1,874

Table 6 (continued)

Kelime	VAL MN	VAL STDV	AR MN	AR STDV	DOM MN	DOM STDV
hasar	2,956	1,413	6,200	1,902	4,244	1,848
haşere	2,444	1,324	6,267	2,250	3,711	2,085
hasta	2,711	1,753	5,711	2,455	3,800	2,282
hile	2,511	1,740	6,489	2,007	4,044	2,345
içecek	6,933	1,643	5,400	2,060	5,889	1,874
içerik	6,111	1,481	4,978	1,559	5,533	1,486
idam	1,911	1,832	7,533	2,085	3,622	2,972
idrar	3,400	1,763	5,133	1,984	4,422	2,137
ihmal	2,911	1,459	5,867	2,085	4,800	2,370
ilaç	4,533	2,095	4,978	1,936	5,133	2,018
ilgi	7,644	1,317	5,756	2,432	6,733	2,082
iltihap	1,867	1,057	6,356	1,694	3,644	2,013
irin	2,178	1,600	5,932	2,028	3,698	1,807
işgüzarlık	3,578	2,017	5,556	2,006	5,156	1,953
isim	6,267	1,529	4,844	1,783	5,356	1,583
ıslık	5,889	1,774	4,911	2,043	5,756	1,721
istila	2,689	2,043	7,022	1,925	3,689	2,512
izmarit	2,244	1,681	5,844	1,965	4,289	2,128
jilet	4,511	1,590	5,600	1,543	4,889	1,695
kabalık	2,578	1,699	6,378	2,269	4,978	2,536
kafatası	3,800	1,995	6,067	2,136	4,644	1,811
kalorifer	6,733	1,514	4,318	1,914	5,333	1,508
karamsarlık	2,311	1,395	5,911	2,043	4,089	2,601
karanlık	4,044	2,067	6,111	2,248	4,778	2,265
karayolu	6,044	1,381	5,489	1,817	5,489	1,604
kaya	5,067	1,156	5,244	1,773	5,022	1,725
kaza	1,778	1,241	7,889	1,229	3,400	2,397
ketçap	5,578	1,469	4,956	1,623	5,311	1,379
kibir	2,822	1,775	5,822	2,386	4,489	2,292
kitap	7,600	1,587	5,756	2,288	6,222	1,704
kızamık	3,022	1,712	5,156	2,088	3,911	1,819
kızamık	2,956	1,678	5,778	1,987	3,689	1,832
kokuşma	1,933	1,321	5,800	2,180	3,822	1,922
komedi	8,044	1,242	6,622	1,980	6,200	2,117
konsantre	6,667	1,446	4,867	2,074	6,467	1,618
korunma	5,911	1,535	4,578	1,971	5,333	2,335
köy	5,533	1,866	4,133	1,961	5,067	1,982
kreş	6,044	1,637	4,844	1,745	4,844	1,988
kucak	7,556	1,470	4,711	2,897	6,289	2,191
küçümseme	2,556	1,358	5,844	2,011	4,489	2,018
küf	3,159	1,446	5,333	1,822	4,311	1,794
kumaş	5,933	1,529	4,644	2,298	5,444	1,778
kumsal	7,636	1,259	4,578	2,709	6,044	1,977
kurbağa	5,022	1,948	4,889	1,874	5,000	1,243
kurcalama	4,444	1,778	5,467	1,660	5,467	1,753
kürk	4,689	2,234	4,933	2,270	5,489	1,973

Table 6 (continued)

Kelime	VAL MN	VAL STDV	AR MN	AR STDV	DOM MN	DOM STDV
kuşku	3,267	1,601	6,356	1,861	4,444	2,272
küstahlık	2,622	1,969	6,511	1,938	4,800	2,361
leş	1,600	1,156	6,067	2,490	3,533	2,191
lezzet	8,333	0,905	7,156	1,894	6,556	2,006
maç	5,733	2,038	6,467	2,191	5,444	1,972
madde	5,136	1,133	4,889	1,112	4,733	1,483
mahremiyet	5,600	1,970	5,022	2,039	6,200	2,322
mahzen	4,844	1,796	5,511	1,938	5,267	1,776
makas	4,978	1,852	5,578	1,738	5,511	1,502
malzeme	5,622	1,302	4,864	1,747	5,222	1,664
mantar	5,467	1,779	4,822	1,683	4,800	1,290
mazeret	4,133	1,517	5,556	1,686	4,911	2,043
melek	7,378	2,059	5,067	3,033	5,000	2,688
meltem	6,756	1,264	3,933	2,406	5,489	2,212
mezar	2,044	1,718	5,978	2,726	2,911	2,162
neşe	8,311	1,062	6,044	2,977	7,222	2,021
nezaket	8,289	1,058	4,311	2,891	7,200	1,673
oda	6,422	1,515	4,178	1,910	5,444	1,673
ödül	7,556	1,603	6,267	2,571	6,523	2,357
ofis	6,044	1,637	5,556	1,603	5,756	1,654
öğretmen	6,600	2,005	5,022	2,350	5,689	2,457
ordu	5,489	2,464	6,822	2,070	4,511	2,967
patika	6,156	1,507	4,844	1,846	5,400	1,615
pişik	3,067	1,711	5,422	1,751	4,022	2,072
pislik	2,089	1,221	5,911	2,275	4,133	2,262
pürüz	3,044	1,313	5,756	1,979	4,778	1,987
raslantı	6,750	1,740	6,778	1,608	4,689	2,304
ray	5,467	1,307	5,289	1,817	4,956	1,623
renk	7,178	1,800	5,778	2,383	6,244	1,708
rüşvet	2,267	1,711	6,933	2,168	4,489	2,735
saat	6,444	1,631	5,644	1,897	5,467	2,242
saat	5,978	1,515	5,111	2,003	4,711	2,085
sabır	6,400	2,157	3,978	2,435	6,711	2,342
saçmalık	3,222	1,731	5,756	2,144	4,689	2,183
şahin	5,644	1,932	6,089	2,172	4,978	1,889
saldırı	1,956	1,364	7,978	1,305	4,311	2,867
sanayi	5,733	1,601	5,578	1,960	4,800	2,242
şapka	6,044	1,718	4,978	1,971	5,578	1,672
şarap	7,289	1,604	5,556	2,519	6,600	1,514
sarılma	8,111	1,335	5,867	3,159	7,156	2,266
sataşma	3,222	1,833	6,444	1,995	4,822	2,386
savunma	5,267	1,763	6,022	1,865	6,222	2,225
saygı	7,341	1,627	4,400	2,435	6,889	2,228
sayı	6,267	1,529	5,267	1,827	5,844	1,705
şefkat	7,911	1,443	4,200	2,966	6,089	2,618
şekil	5,733	1,250	4,778	1,412	5,311	1,474

Table 6 (continued)

Kelime	VAL MN	VAL STDV	AR MN	AR STDV	DOM MN	DOM STDV
şelale	7,378	1,556	6,200	2,408	5,400	2,147
sevgili	8,489	0,815	6,578	2,792	6,689	2,382
sıçan	2,689	1,844	6,889	1,933	3,818	1,944
sihirbaz	5,711	1,950	6,378	1,838	5,022	1,725
şiir	6,467	1,902	5,178	2,198	5,289	2,263
sıkıntı	2,422	1,373	6,089	2,382	4,489	2,242
sinema	7,511	1,121	5,467	2,446	5,933	2,005
şirinlik	7,244	1,525	5,089	2,265	6,156	2,195
sirk	6,333	2,576	6,133	2,212	5,333	1,846
sivrisinek	2,222	1,594	6,311	2,172	3,667	2,056
sızlanma	2,844	1,537	5,622	2,146	4,756	2,058
solucan	3,289	1,792	5,444	2,062	3,667	1,989
sonbahar	6,444	2,117	3,756	2,506	5,333	2,365
sprey	4,844	1,397	4,956	1,623	4,867	1,604
suç	2,756	1,824	7,044	1,930	4,659	2,614
suçiçeği	2,711	1,456	5,978	1,815	4,244	2,036
sükunet	7,111	1,613	2,867	2,399	5,568	2,500
süprüntü	3,244	1,640	5,667	2,045	4,600	1,959
tabanca	2,533	2,007	7,800	1,517	4,089	2,976
tabure	5,222	1,042	4,467	1,546	4,911	1,258
tabut	2,356	1,990	6,289	2,537	3,244	2,186
taciz	1,867	1,486	7,467	1,687	3,667	2,812
tahriş	3,333	1,492	5,422	1,852	4,000	1,552
tahta	5,689	1,395	4,356	1,708	5,444	1,407
takırtı	3,178	1,655	6,222	2,021	4,267	2,016
tank	2,933	1,876	7,200	1,804	3,533	2,735
tanrı	6,622	1,886	5,422	2,563	4,400	2,950
tapınma	4,644	2,308	5,133	2,063	4,089	2,466
tarz	6,333	1,692	5,467	1,829	6,477	1,438
tasarruf	6,156	1,692	4,511	2,117	5,911	1,998
tatlı	7,533	1,254	5,222	2,044	5,889	1,861
tebessüm	8,511	0,787	6,533	2,492	7,644	1,640
tebrik	7,644	1,151	5,295	2,329	6,444	2,262
tehdit	1,933	1,421	7,622	1,762	4,400	2,562
teori	6,289	1,687	5,600	1,827	5,311	1,856
teselli	6,178	1,813	3,711	2,160	5,756	2,134
tütün	3,889	2,639	5,489	2,181	5,333	2,205
üşüme	3,622	1,762	5,600	2,240	4,533	2,292
uyum	7,467	1,561	4,533	2,817	6,511	2,041
uyuşturucu	1,933	1,763	6,978	2,251	4,289	3,042
üzüntü	2,867	1,740	6,200	2,302	3,600	2,260
vücut	6,578	1,644	5,956	1,678	6,111	1,837
yabancı	5,578	1,777	5,733	1,724	5,455	1,784
yalan	2,341	1,867	6,911	2,065	4,622	2,471
yara	2,667	1,398	5,933	1,959	4,267	2,250
yas	2,133	1,660	5,467	2,399	4,289	2,590

Table 6 (continued)

Kelime	VAL MN	VAL STDV	AR MN	AR STDV	DOM MN	DOM STDV
yatırım	6,044	1,783	6,273	2,016	5,756	1,873
yazar	7,133	1,575	5,178	2,443	5,844	1,833
yazı	6,444	2,149	5,489	2,212	6,356	1,909
yelkenli	7,356	1,495	5,578	2,808	6,045	1,642
yığın	4,467	1,408	4,956	1,507	4,689	1,276
yıldız	7,689	1,395	4,933	2,934	5,667	2,276
yozlaşma	1,956	1,507	6,244	2,069	4,044	2,236
yük	4,244	1,417	5,311	1,794	5,289	1,701
yuva	7,467	1,646	3,489	2,617	6,156	2,335
zaman	5,978	1,852	5,711	2,342	4,911	2,678
zarafet	8,133	1,198	4,822	3,002	6,867	1,646
zarar	2,444	1,358	7,022	2,039	4,556	2,417
zevk	7,864	1,340	6,111	2,925	6,756	2,155
zimmet	2,489	1,792	6,067	2,115	4,378	2,279
zorluk	4,533	2,029	6,444	2,127	5,111	2,442

VAL MN: Valence mean
VAL STDV: Valence standard deviation
AR MN: Arousal mean
AR STDV: Arousal standard deviation
DOM MN: Dominance mean
DOM STDV: Dominance standard deviation

APPENDIX C: WORDS USED IN EXPERIMENT 2

Negative Words	Neutral Words	Positive Words
Yük	zaman	zevk
Yığın	yatırım	zarafet
Yas	yabancı	yıldız
Yara	vücut	yelkenli
Üşüme	şapka	yazar
Tütün	şahin	tebrik
Tahriş	sirk	tatlı
Süprüntü	sihirbaz	şirinlik
Solucan	savunma	şelale
Sızlanma	sanayi	şarap
Pişik	saat	sinema
Pislik	ray	sarılma
Mezar	patika	renk
Küf	ofis	ödül
Küçümseme	mantar	neşe
Kokuşma	malzeme	melek
Kibir	mahremiyet	kucak
Kızamık	madde	konsantre
Karamsarlık	maç	kitap
Izmarit	kreş	ilgi
Işgüzarlık	kaya	içecek
Irin	karayolu	güzellik
Ihmal	içerik	günbatımı
Idrar	ıslık	gündoğumu
Hasta	harf	gülümseme
Gübre	haber	gökkuşağı
Eşcinsellik	gökdelen	gemi
Egoizm	gelenek	fener
Düğüm	fırın	duygu
Domuz	etki	dostluk
Dilenci	el	doğa
Dert	doktor	dergi
Çöplük	demir	çimen
Çamur	davranış	çarşı
Bataklık	cinsiyet	civciv
Batak	ciddiyet	ayrıntı
Balçık	cadde	ay
Ayyaş	boya	ampül
Angarya	asansör	altın
Abes	alet	ağırlama

APPENDIX D: IAPS NUMBERS OF PICTURES USED IN EXPERIMENT 2

Negative Pictures	Neutral Pictures	Positive Pictures
1019	1121	1340
1070	1303	1440
1090	1390	1460
1110	1640	1463
1111	1650	1590
1201	1660	1710
1270	1720	1721
1274	2025	1722
1275	2372	1740
1301	2389	1811
2100	2410	1920
2110	2605	2160
2120	2606	2170
2141	5455	2224
2312	5535	2311
2375	5628	2340
2399	6900	2341
2710	7211	2346
2900	7289	2391
4621	7352	2398
6190	7390	2550
6570	7402	2650
6940	7450	2660
9102	7460	4626
9110	7472	5260
9180	7482	5600
9280	7487	5623
9340	7510	5700
9341	7560	5830
9342	7600	5831
9390	8033	5910
9440	8041	7230
9470	8130	7260
9471	8192	7270
9530	8211	7430
9611	8250	7580
9830	8260	8190
9911	8280	8210
9912	8371	8420
9925	8467	8540

APPENDIX E: EXPERIMENT 2 INSTRUCTIONS

VERBAL RECOGNITON TASK

YÖNERGE

Bölüm 1

Bu çalışmaya katıldığınız için teşekkürler. Bu çalışma iki bölümden oluşmaktadır. Birinci bölümde ard arda kelimeler göreceksiniz. Lütfen bu kelimeleri dikkatli okuyunuz çünkü ikinci bölümde bu kelimeleri hatırlamanız beklenmektedir. Birinci bölümde her kelimeyi okuduktan sonra o kelimenin somut bir kelime mi yoksa soyut bir kelime mi olduğunu düşününüz. Birinci bölümde kelimeleri dikkatle okumaktan ve soyut/somut kararını vermekten başka bir şey yapmanız gerekmemektedir. Ekranda belirtildiği zaman sarı tuşa basarsanız birinci bölüme başlayabilirsiniz. Bu bölüm bittikten sonra ikinci bölüme geçmeden 1 saat ara verilecektir.

Bölüm 2

Bu çalışmanın ikinci bölümünde yine kelimeler göreceksiniz. Bu kelimelerin bazıları bir önceki bölümde gördüğünüz kelimeler, bazıları da yeni kelimeler olacaktır. Bu bölümde sizden beklenen kelimeleri bir önceki bölümde görüp görmediğinizi bildirmenizdir. Eğer kelimeyi hatırlıyorsanız ve kelimenin bir önceki listede olduğundan eminseniz lütfen kırmızı tuşa basınız. Daha detaylı olarak, kelimeyi gördüğünüzde düşündüklerinizi anımsayabiliyorsanız, kelimeyi okuduğunuz an gözünüzde canlanıyorsa veya kelimenin fiziksel özellikleri ile ilgli herhangi bir şey aklınıza geliyorsa kelimeyi hatırlıyorsunuz demektir. O zaman kırmızı tuşa basarak bir sonraki kelimeye geçebilirsiniz. Eğer kelimeyi tanıdığınızı düşünüyorsanız, yani kelimeyi ilk bölümde gördüğünüzü bilinçli olarak hatırlayamıyor ama o kelimenin ilk listede olduğuna eminseniz bunu sarı tuşa basarak belirtebilirsiniz. Başka bir deyişle, kelimeyi gördüğünüz anda ne yaptığınızı veya düşündüğünüzü bilemediğinizde ama kelimeyi tanıdığınıza inandığınızda sarı tuşa basarak bir sonraki kelimeye geçebilirsiniz. Eğer kelimeyi bir önceki bölümde görmediğinize eminseniz, yani o kelime yeniyse yeşil tuşa basınız ve bir sonraki kelimeye geçiniz.

Hatırlama (kırmızı tuş) ve tanıma (sarı tuş) kararınızı verebilmek için bir örnek verebiliriz. Mesela biri isminizi sorduğunda vereceğiniz cevap “tanıma” hissi ile olacaktır. Çünkü ilk anda bu cevapla ilgili bir olay veya tecrübe gözünüzde canlanmaz. Ancak en son hangi kitabı okuduğunuz sorusunun cevabını “hatırlama” hissi ile verirsiniz. Mesela kitabı aldığınız veya onu okuduğunuz anlar gözünüzde canlanır.

VISUAL RECOGNITON TASK

YÖNERGE

Bölüm 1

Bu çalışmaya katıldığınız için teşekkürler. Bu çalışma iki bölümden oluşmaktadır. Birinci bölümde ard arda resimler göreceksiniz. Lütfen bu resimleri dikkatli inceleyiniz çünkü ikinci bölümde bu resimleri hatırlamanız beklenmektedir. Birinci bölümde her resmi inceledikten sonra o resmin karışık bir resim olup olmadığını düşününüz. Birinci bölümde resimleri dikkatli incelemekten ve karışık olup olmadığını düşünmekten başka bir şey yapmanız gerekmemektedir. Ekranda belirtildiği zaman sarı tuşa basarsanız birinci bölüme başlayabilirsiniz. Bu bölüm bittikten sonra ikinci bölüme geçmeden 1 saat ara verilecektir.

Bölüm 2

Bu çalışmanın ikinci bölümünde yine resimler göreceksiniz. Bu resimlerin bazıları bir önceki bölümde gördüğünüz resimler, bazıları da yeni resimler olacaktır. Bu bölümde sizden beklenen resimleri bir önceki bölümde görüp görmediğinizi bildirmenizdir. Eğer resmi hatırlıyorsanız ve resmin bir önceki listede olduğundan eminseniz lütfen kırmızı tuşa basınız. Daha detaylı olarak, resmi gördüğünüzde düşündüklerinizi anımsayabiliyorsanız, resmi incelediğiniz an gözünüzde canlanıyorsa veya resmin fiziksel özellikleri ile ilgili herhangi bir şey aklınıza geliyorsa o resmi hatırlıyorsunuz demektir. O zaman kırmızı tuşa basarak bir sonraki resme geçebilirsiniz. Eğer resmi tanıdığınızı düşünüyorsanız, yani resmi ilk bölümde gördüğünüzü bilinçli olarak hatırlayamıyor ama o resmin ilk listede olduğuna eminseniz bunu sarı tuşa basarak belirtebilirsiniz. Başka bir deyişle, resmi gördüğünüz anda ne yaptığınızı veya düşündüğünüzü bilemediğinizde ama resmi tanıdığınıza inandığınızda sarı tuşa basarak bir sonraki resme geçebilirsiniz. Eğer resmi bir önceki bölümde görmediğinize eminseniz, yani o resim yeniyse yeşil tuşa basınız ve bir sonraki resme geçiniz.

Hatırlama (kırmızı tuş) ve tanıma (sarı tuş) kararınızı verebilmek için bir örnek verebiliriz. Mesela biri isminizi sorduğunda vereceğiniz cevap “tanıma” hissi ile olacaktır. Çünkü ilk anda bu cevapla ilgili bir olay veya tecrübe gözünüzde canlanmaz. Ancak en son hangi kitabı okuduğunuz sorusunun cevabını “hatırlama” hissi ile verirsiniz. Mesela kitabı aldığınız veya onu okuduğunuz anlar gözünüzde canlanır.