

Characteristics of Odor-evoked Memories

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*To my family...*

## Abstract

### Characteristics of Odor-evoked Memories

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The aim of the present study is to provide a descriptive picture of odor evoked memories and define the most common odors that evoked memories. Moreover it is aimed compare characteristics of memories evoked by verbal, visual and olfactory cues. Also, the metacognitive judgments in odor evoked memories are investigated and they are compared with verbally and visually cued memories. To fulfill these purposes two experiments were conducted in this study. In study one participants were asked if they had a memory that is evoked by an odor and also asked to indicate which odor evokes memories. In the second experiment the differences between verbal, visual and odor cued memories were investigated by a well established and frequently used scale, Rubin's Autobiographical Memory Questionnaire. Participants were randomly assigned to one cue type group and they were presented seven cue items. The results showed that it was common to have an odor evoked memory and perfume was found to be most common odor that evokes memory. Also there was great inter individual variability with regard to odors that evoke memories. The characteristics of memories were found to be similar for verbal, visual and olfactory cues. Like other measures included in AMQ, emotionality, vividness, feeling of brought back, age at event and novelty of memories did not show any significant difference. However, there was a difference in metacognitive judgments and each cue type had different contributing variable for each judgments.

## Kisa Özet

### Kokularin Çağrıldığı Otobiyografik Anıların Özellikleri

Görgün Yılmaz

Bu araştırmanın amacı kokuların çağrıldıkları anıları genel bir çerçevede tanımlamak ve hangi kokuların ani çağrılmada en yaygın olduğunu belirlemektir. Dahası, kelimelerin, fotoğrafların ve kokuların çağrıldıkları anıların özelliklerini karşılaştırmak da amaçlanmaktadır. Kokuların çağrıldıkları anılarda üst bilis kararları da incelenmiş ve bu kararlar kelimelerin ve fotoğrafların çağrıldıkları anılarla karşılaştırılmıştır. Bu amaçları yerine getirmek için iki deney yürütülmüştür. Birinci deneyde katılımcılara kokuların çağrıldıkları bir anıları olup olmadığı sorulmuş ve hangi kokunun onlarda bir ani çağrıldığını belirtmeleri istenmiştir. İkinci deneyde kelime, fotoğraf ve kokuların çağrıldığı anılar arasındaki farklar etkinliği bilinen ve sıkça kullanılan bir ölçek olan Rubin'in Otobiyografik Ani Anketi (OAA) ile incelenmiştir. Katılımcılar rastgele olarak bir uyaran grubuna atanmış ve yedi uyarana tabi tutulmuştur. Sonuçlar kokuların çağrıldıkları bir anıya sahip olmanın yaygın olarak görüldüğünü ve bu anıların en sık parfüm tarafından çağrıldığını göstermiştir. Dahası, katılımcılar arasında hangi kokuların ani çağrıldıkları konusunda büyük farklar görülmüştür. Kelime, fotoğraf ve kokuların çağrıldığı anıların özelliklerinin birbirine benzer olduğu bulunmuştur. OAA'da bulunan diğer ölçümler gibi anıların duygusallığı, canlılığı, olay anına geri dönmüş hissi, düşünülme sıklığı ve olayın olduğu yasta anlamlı bir fark bulunmamıştır. Ancak, üst bilis kararları kelime, fotoğraf ve koku grubu için farklılık göstermiş ve her karara farklı değişkenler etki etmiştir.

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## 1.INTRODUCTION

### 1.1. Autobiographical Memories

There has been an increase in the studies on autobiographical memories in last few decades. Although there is some debate on what autobiographical memories refer to, one's recollection of his/her past experience is accepted as the basic definition. This definition derives from Brewer (1996). He divides autobiographical memories into four groups based on their acquisition conditions (repeated vs. single) and form of representation (imaginal vs. nonimaginal). Based on this categorization the recollective memories are the ones that are single and imaginal. Thus, Brewer(1996) indicate that, reliving of the phenomenal experience, the presence of information about place, actions, people thoughts or affects as a mental image is the basic properties of recollective memory. However, there are two basic theoretical accounts of autobiographical memories.

The first is by Conway and Pleydell-Pearce (2000) and it proposes a model of autobiographical memories that has two basic components; the knowledge base and the working self system. These two components combine and form the self-memory system. According to this view, autobiographical memories derive from the underlying knowledge base which is minutely sensitive to the cues. However, activation of the base may or may not turn into memories or consciousness based on an executive system. The knowledge base contains knowledge on three hierarchical levels of specificity. The first is the lifetime period and it is contains of information

of a period thematically and temporally as representing common locations, activities, goals and significant others of the period. This period has identifiable beginnings and endings but these borders may be fuzzy. Examples to the life time period may be “when I was six”, “when I was in university”, or “when I lived in x”. The second is the general event and in this level, memories are more specific than the life time periods. These kinds of memories may be single or repeated but they are generally vivid events related to attainment or failure of a goal. “Visits to Paris” can be given as an example to the repeated general events and “a lunch in x” can be given as an example to the single general event. Especially, the first time memories are an important category of general events and they serve to determine the nature of the self. The last level is the event-specific knowledge and in this level, memories are most specific. In this level, memories are vivid, more detailed, there is a mental imagery for them and the memory includes a relatively shorter time period than the other types. Examples for this level may be “the feeling of anxiety”, “one specific incident in a trip to somewhere”. Researchers have emphasized event specific knowledge in its centrality in autobiographical memories (Brewer, 1986) and this level of knowledge has been mostly investigated in autobiographical memory studies since Galton (1883). According to Conway, this level of knowledge can be accessed through two ways: either a thematic knowledge is accessed first and then other details accessed later or knowledge is accessed from first occurring activities to the last one sequentially. Moreover, in ESK, there is great variability, that is, in some memories many details are remembered but in some, no details could be accessed. Conway (2000) argues that this is due to the rapid loss of ESK links to general events in the case the links are unrehearsed. So overall, these three levels are hierarchical and a specific autobiographical memory is the activation over three levels.

Moreover, it is argued that, as the knowledge base is continuously reactive to the cues, these cues may be very specific such as odors or very abstract such as math problem. Based on that, the specificity of the cue may lead to activation of different indexes and based on the ability of the cues to directly activate ESK, stable and distinct memories are formed. On the other hand, these ESK should have mapping on general event and general event should have mapping on life time period for the memories to be formed. After these processes, this knowledge base interacts with the second basic component the working self. Working self includes the goals and plans of an individual and it functions in encoding and retrieval of autobiographical memories. Each of the processes identified before, passes through the working self component and then memories are formed. Thus, Conway suggests that this interactive process creates the self-memory system.

The other theory comes from Rubin and colleagues (2003, 2005). According to that theory, autobiographical memories are formed of component processes. These processes are visual imagery, auditory imagery, language, narrative form and emotion. For a full-blown autobiographical memory, all of these component processes should be present but they can vary in degree of presence. Aside from the component processes, Rubin's theory also indicates two metacognitive judgments formed by the interaction of component processes. These judgments are belief and recollection. In other words, according to Rubin and colleagues, to have an autobiographical memory, one should have to recollect (or relive) it and believe that the event actually occurred. For the investigation of component processes and judgments, Rubin (2003) created the Autobiographical Memory Questionnaire that measures the component processes with one or more questions and derives the metacognitive judgments from the interaction of components.

### 1.1.1. Cuing in Autobiographical Memories

There are plenty of studies on ABM in literature and each study focuses on different aspects of ABM but most commonly, the memories evoked by verbal and semantic cues are used for these investigations. The popularity of the semantic evocation for memories comes from 1879. The first use of verbal cues to evoke memories was by Galton (1879) but his use of this technique was not limited to personal memories. In his research, he gave himself a word and tried to find an association to that word. What came out were different kinds of memories such as perceptual memories or linguistic responses. Crovitz and Schiffman (1974) used this technique first time for the specific personal memories. On the other hand, verbal cues are not the only type of cues used to evoke autobiographical memories. There are also other cues used to evoke memories such as visual, auditory or odor but the use of these cues are much less in the literature. However, interestingly there is a wide public belief that among these less studied cues, odors are special in terms of their efficacy in evoking vivid, old and detailed memories. This belief derives from the novel *Swann's Way* (Proust, 1928).

## 1.2. Odor Evoked Memories

### 1.2.1. Anecdotal Studies

The first indication of odors' potency in evoking autobiographical memories was by Proust (1928) in his novel *Swann's Way*. In his novel, he mentioned his personal experience as an anecdote saying when he dipped his Madeline biscuit to his tea the smell suddenly evoked a childhood memory of him very vividly. After Proust's (1928) anecdote a belief that odors are especially provocative reminders of autobiographical memories emerged. However, this belief was not studied

experimentally for a long time. In the first empirical study on the topic (Laird, 1935) 254 men and women provided retrospective accounts of their odor-evoked memory experiences. First of all, it was found that eighty percent of men and ninety percent of women had such kind of memory but no statistical analyses were carried out in this study. Next, when the reported memories were investigated, they were found to be highly emotional and vivid. In addition, women also have more emotional and vivid memories than men do.

### 1.2.2. Experimental Studies

The first experimental study on odor-evoked memories was by Rubin, Groth and Goldsmith (1984). In that study, the aim was to compare the characteristics of memories evoked by different cues. Three different cues were used and these were photographs (visual), names (semantic) and odors. Twenty-seven stimuli were used for each condition. For the selection of stimuli, familiarity was used as one criterion because it was argued that, odors needed to be familiar to evoke autobiographical memories. The second criterion was identifiability of odors with a single word because only by this way the comparison of memories evoked by odors and words could be possible. The last criterion for selection was for odors to cover a wide range of substances. Each subject received one type of cue and reported the memory evoked by them. This was called single cue comparison method because the cue type was used as between subject variable. After the participants reported their memories, they rated these memories on vividness, emotionality at time of event, emotionality at time of rehearsal, how many times it had been thought of, how many times it had been talked about and last recall time of event on seven point Likert type scales. Lastly, each memory was asked to be dated as accurately as possible. The results showed that, odor-evoked memories were not more emotional or vivid than the

memories evoked by cues in different modalities. On the other hand, odor evoked memories were found to be less thought of and less talked about. Also odor evoked memories were more pleasant than memories evoked by other cue modalities. Thus, this study was first to show an experimental characterization of odor-evoked memories and the results were opposed to folk wisdom and Laird's earlier study. However, later evaluation of this study (Schab, 1991; Herz and Cupchik, 1992, Herz and Schooler, 2002) pointed out that the results should be approached cautiously because a restricted set of stimuli as odors were used and there is a great inter-individual variability for odor memory (Schab, 1991), the cue type was used as between subject variable (Herz and Cupchik, 1992) and odors were not specifically chosen to elicit childhood memories (Herz and Schooler, 2002). These criticisms are important in the sense that, the results found by Rubin et. al. (1984) may not be reliable as a result of inter-individual variability in odor memory as Schab (1991) indicated. Thus, many more studies should be conducted on this issue by using different sets of odors for a clearer conclusion. In addition, as Herz and Schooler (2002) indicate the selection of stimuli is very important such that the memories may not be found to be old because the stimuli were not especially chosen from childhood period. Again, this criticism indicates the necessity of replication of Rubin et. al. (1984) study with different set of stimuli.

The next experimental study on odor-evoked autobiographical memories come from Herz and Cupchik (1992). In this study, the belief since Proust that odor-evoked memories were specific, emotional, vivid, rare and older was investigated experimentally and it was aimed to provide a descriptive account of the nature of autobiographical memories after Rubin et. al. (1984) but in addition, in this study the influence of sex and orienting sets was also included. Based on the Laird's (1935)

finding of sex difference, Herz and Cupchik investigated whether sex makes difference but this variable was investigated by its interaction with the other variable, the orienting set. The orienting set concept was defined as the environmental context in which a person encounters odors. The orienting set was either subjective or objective. The subjective set included the personal feelings in evaluation of odors and no intention of being objective was present. On the other hand, in objective set, participants tried to be objective, bias free and not to include their personal beliefs, likes. The kind of set participants assigned were was expected to interact with gender in the emotionality and vividness ratings for memories evoked. Therefore, the hypotheses were that women would have more emotional and vivid odor memories than males and if set has an influence this would be as a facilitative effect for females under subjective set. The subjects first had to identify four of the five commonly used odors presented to them in order to be included in the study. In the experiment, 20 odors were used. There were equal numbers of pleasant and unpleasant odors but they ranged in the familiarity and distinctiveness. The subjects were grouped into two as objective and subjective orienting sets randomly. The objective orienting set group received the instruction that “It is very important to be as analytical as possible while judging the odors. In other words, I want you to be very objective and scientific. Odors are frequently evaluated in the chemical industry on a variety of dimensions. In this study, I would like you to think of yourself as a chemist and rate the odors in terms of their physical qualities. ” and the subjective orienting set group received the instruction that “I want you to relax and try to relate to the odors in a personal way. While you are judging the odors to think of how they make you feel and what they mean to you. Different people have different personal responses to odor experiences. When you are experiencing the odors today, I would like you to

pay attention to your feelings and the thoughts that come to you have.”. After the instruction odors were presented to each subject one by one and after each odor the subjects rated these odors pleasantness, intensity, arousal, interest and familiarity. Next, the subjects were asked if they could name the odor. After that, subjects were asked if any autobiographical memories were evoked by these odors and if the answer was yes, a brief written description was obtained. Lastly, the subjects rated their reported memories on emotionality, clarity, rarity, specificity and age on seven-point scales. The written descriptions of memories were later scored by two independent judges on vividness and number of emotion descriptors. For analysis of emotionality, the scores from the both end points of scales (very positive and very negative) were compared against the scores from the middle (neutral). It was found that, 60% of memories were highly emotional either from very high or low (53% positive and 7% negative). Only 39% of the memories were rated as neutral. The difference was significant. For analysis of clarity, specificity and rarity, the scores from both endpoints was compared (1 plus 2 versus 6 plus 7). In clarity, 50% was very clear and 14% was vague. In rarity, 55% was hardly thought and 12% was frequently thought. For specificity, 47% was a specific incident and 23% was general feeling. All differences were statistically significant. For vividness rated by judges from the written descriptions same kind of analysis were conducted, and it was found that 63% was highly vivid and 6% was low vivid and the difference was also significant. For age, the greatest number of memories were from last 1-4 years or greater (63%) and the 27% of the rest was from last year. In addition, from the six time periods that subjects could choose from if they aged their memory as greater than last four years, the largest proportion (25%) was from early childhood. The relationship between the experience of odors and evocation of memories was also

investigated. From the five odor-scales familiarity was the single best predictor for whether or not an odor would evoke a personal memory. More familiar was the odor; greater numbers of memories were evoked. Familiarity was also the best predictor of naming an odor, and the correlation between odor naming and odor memory evocation was significant. In further analysis of relation between odor naming and memory evocation it was found that memories were evoked mostly after correct naming of odor, however, 32% of memories were without naming. This shows that naming is important but despite the lack of it, memories can be evoked, so semantic association is not a pre-condition for memory evocation. The investigation of sex and set influence on memory ratings revealed that there was a significant main effect of sex in emotional descriptors and memory clarity; females were higher on both. In addition, there was a significant sex by set interaction; females in subjective set had more vivid memories than females in objective set. So, overall the odor-evoked memories were found to be vivid, emotional, rare, clear, rarely thought of and old. Also importantly, it was also shown that odor naming was not a necessary pre-condition for odors to evoke memories. As a support of Laird (1935), sex made difference so that females had more emotional and clearer memories and also as expected sex interacted with set. Lastly, familiarity was found to be an important indicator of whether subjects could name an odor or an odor would evoke a memory.

Although Herz (1992) study was aimed to investigate characteristics of odor cued memories, in that study only odors were used and no comparisons between different cues modalities were conducted. The first comparison study after Rubin et. al. (1984) was by Herz and Schooler (2002). In this study, the aim was the same as Rubin (1984) that is determining the characteristics of autobiographical memories evoked by different cue types. However, Herz and Schooler (2002) criticized Rubin's

single cue comparison method for the reason that by this technique the cue itself might lead to the selection of different memories and for selection of memories, odor, visual or semantic cues are not comparable. In other words, when the cues from different modalities are given to the subject, for all modalities they first choose a memory by the cue and then evaluate it on scales. In that case, the evoked memories by different cue types may not be equally emotional or vivid. For example, by a semantic cue, a more emotional memory may be chosen and the result may be due to this selection not the efficacy of the cue in the retrieval process. So that the differences found by Rubin et. al. (1984) study might be due to memory selection bias, not the cue's influence on retrieval process. For this reason, Herz and Schooler (2002) used double cuing technique in which each participant received each cue type sequentially but first was always verbal. By this way, memory selection bias would be eliminated because each subject chose the memory by the same cue modality and re-evaluated the memory later with the help of other cue modalities. Moreover, Herz and Schooler (2002) also indicated that the odors chosen for Rubin et. al. (1984) study were all familiar and these odors were connected to daily routine events. However, it is known from the study of Herz (1997) that odors are better reminders of past experience if they are novel and distinctive from the environment. Based on this, it is the childhood period where odors were connected to emotional events because only in that time period everything is new and meaningful (Herz and Schooler, 2002). Thus, Herz and Schooler indicated that odor selection is an important factor for the lack significant findings in emotionality and age of memories evoked by odors in Rubin et. al. study (1984) and they aimed to replicate and extend Rubin (1984) study by using different set of odors which were chosen especially to elicit past childhood memories and double cuing methodology. By these changes,

they expected to find a difference in both emotionality and evocativeness for odor-evoked memories.

The odors used were Johnson and Johnson baby powder, Vicks Vapor rub, Playdoh, Crayola crayons and Coppertone suntan lotion. Verbal labels printed on paper were used for verbal cue type and colored photographs of items were used for visual cue type. Subjects always received the verbal cue first and they were asked to think of a personal memory associated with the item. Then, the subjects rated the memory on age at memory encoding, memory vividness, specificity of memory, emotionality at the time of event, emotionality at the time of rehearsal and feeling of being back brought during recollection. After this phase, the second phase came where subjects received either the visual or odor form of the same cue and they completed all scales except age of memory the second time.

The changes in the ratings of scales were analyzed and the results showed that, when the second cue (the recollection cue) was odor, memories were more emotional and subjects felt more brought back than the recollection cue was visual. Also, as the odors were chosen specifically to elicit childhood memories, the ages of memories were computed and the result was 15.8 years. This was not related to odor-evoked memories because all memories were selected by verbal cue but still the memories might be considered old as the mean age of subjects were 33. No differences in vividness and specificity ratings between different cue types were found.

This study was first to compare different cue types for autobiographical memories after Rubin et. al. (1984) and it was shown that memories were more emotional and subjects felt themselves more brought back by odor cues. More importantly, by the use of new double cuing technique, the efficacy of odors was

found to be on retrieval process and the aid of odors on memory was shown to be in recollection process not in the memory selection process. However, the lack of finding a significant difference for vividness and specificity shows that the anecdote of Proust (1928) and his claim of odors bringing the details of past memories into mind was wrong.

Herz (2004) extended the previous study by adding an auditory cue. The same double cuing methodology was used and again odors were selected specially to elicit past personal memories. These were namely, fresh cut grass, campfire and popcorn. For visual cue, photographs and for auditory cue sound clips of these items were used. In the first phase, subjects were given verbal cues and asked if this evoked a specific personal memory. For the evoked memory a brief written description and emotionality, vividness, specificity and evocativeness ratings were also asked. In the second phase, the odor, auditory and visual forms were presented one by one and subjects were asked to re-think of memory and evaluate it on same scales again. Lastly Attention to and Importance of Odors Questionnaire was given.

In the analysis, responses to questionnaires by cue form results showed, like Herz and Schooler (2002), that odor cued memories were more emotional and subjects felt more brought back to original event but no difference in vividness and specificity was found. Each sensory item was also controlled if they made difference and it was found that only for emotionality campfire led to most emotional memories while popcorn led to least emotional memories. In the study, a mixed age group ranging from 7 to 79 was used. For analysis, the subjects were grouped into four according to their age and age interaction for cue type and memory item was controlled. No interaction for cue type was found but for memory item, a significant interaction was obtained in emotionality and vividness ratings. For sex, no main

effect or interaction was found but for type of residence a significant interaction in vividness and specificity for memory item was found. AIO didn't make a significant difference. So, odor cued memories were shown to be more emotional and evocative than visual or auditory evoked memories. Opposed to Laird (1935) and Herz and Cupchik (1992) no difference for sex was found but it was shown that age and type of residence could make a difference in memory ratings. Finally, it was speculated that the neuro-anatomical character of olfactory area in synapsing directly with the amygdala-hippocampal area would lead the higher emotionality in odor-evoked memories.

Rubin et. al. (1984) investigated whether odor-evoked memories were old but no significant result for age was found. Herz and Cupchik (1992) in their study concluded that odor evoked memories were old but no comparison with other cue types was conducted and Herz (2004) used double cuing method which made comparison of age impossible. Chu and Downes (2000) were first to compare the age of memories for different cue types as an extension of Rubin but they conducted the study on older adults than Rubin because reminiscence bump could only be observed in adults older than 50 years old. The mean age of subjects was 69.4 and each participant received either odors or label of odors. For odor condition, participants were given odor and they were asked to sniff with eyes closed for if they could label the odor. Next, they were asked if they had any specific memory for that odor, and subjects were asked to briefly explain the memory. After all odors were presented, subjects dated each event by giving age or year of event. In label condition, everything was same except that instead of odors labels were given.

The results showed that 47% of memories were from last five years. When the distribution of memories throughout lifespan was investigated, there was a peak

in 11-25 years for verbal condition and there was a peak in 6-10 years for odor condition. By contrast analysis, a quadratic trend for verbal condition and a linear trend for odors condition was found. There were no difference in the infantile amnesia part or the recency part but the reminiscence bump moved toward earlier ages in odor condition. Thus by this study it was shown that odor cued memories tend to be older than verbal cued memories which empirically supports Proust's anecdote (1928).

The age of memories evoked by olfactory cues was investigated by Willander and Larsson (2006) too. They claimed that although Chu and Downes (2000) study showed that odor-cued memories were older than verbally cued memories, the number of participants were only 22. Thus, for a better understanding on age of memories they conducted a study with a larger sample. In addition to the focus on age of memories, other experiential qualities of odor evoked memories such as emotionality, vividness, brought back in time, clarity and importance of memories were also investigated.

A total of 93 participants were used in the study with the mean age of 74. The stimuli were 20 items which were selected based on pilot testing on identifiability and distinctiveness on different sensory modalities. The stimuli were presented in word, picture and odor form and subjects were assigned randomly to one of cue groups. Once the stimuli were presented subjects were asked to rate their memories on emotionality now, emotionality than, vividness, feeling of being brought back, importance, valence now, pleasantness now, intensity, how detailed is the memory and how often they think of memory. Lastly they were asked to date each memory.

In analysis, first of all the number of memories evoked by different cue types were compared and no significant difference was found. That showed each cue had

equal level of efficiency in evocating memories. Next, the distribution of memories across lifespan was analyzed. A main effect of decade and a cue type decade interaction was found. Post-hoc tests showed that the while odor cued memories produced higher proportion of memories from first decade than words and pictures, in the second decade higher proportion of memories were evoked by words and pictures than odors. Other analysis also showed that in odor evoked memories most of memories were from ages 0-10 but in word and picture evoked memories were from 11-20 ages. The results on experiential characteristics showed that picture-evoked memories were more emotional than others, feeling of brought back was highest for odors and other cues didn't differ from each other and lastly odor and word evoked memories were thought of less often than picture evoked memories. There were no other significant differences in experiential characteristics.

Overall this study replicated the finding of Chu and Downes (2000) that odor evoked memories are older and showed that the bump for odor evoked memories for older adults is between 0-10 ages, while it is 11-20 for pictures and words. Moreover, as picture-evoked memories were found to be more emotional it contradicted previous studies (Chu and Downes, 2002; Herz and Cupchik, 1992; Herz and Schooler; 2002, 2004) . Although feeling of brought back was shown to be higher for odor cues and supported Herz and Schooler; (2002, 2004) findings, lack of finding any significant difference between odor and word cues for how often the memory is thought of contradicted Rubin et al. (1984) and Herz and Schooler; (2002, 2004) studies.

These previously mentioned studies all show that odors are different from other cue types in evoking autobiographical memories. Chu and Downes (2002) investigate the underlying reason of odors' difference. Two hypotheses for how

odors differ were investigated. The first one is the differential cue affordance hypothesis and it claims that effect of odor is in retrieval process. Different cue types differ in how efficiently event details can be accessed by them. The second hypothesis is the differential encoding bias hypothesis and it claims that autobiographical memories differ in number of event details encoded and consolidated so as the complexity of the memory increase the peripheral details also increase. As odors are peripheral details, they can only be in memories that are more complex. In the study, ten odors chosen based on familiarity and ease of procurement was used. Double cuing technique like Herz (2002) was used and all participants were cued twice always starting with verbal label of odors. After giving the verbal cue, the participants were asked if it evoked a specific memory and if the answer was yes, they evaluated the memory on seven scales. These scales were pleasantness, embarrassment, painfulness, anxiety, vividness, uniqueness and personally significance. In the next phase, participants were given either the same verbal cue, odor cue that is congruent with the verbal cue or an odor cue not congruent with the verbal cue. After exposure to the second cue participants rated their memory again in the seven scales.

Overall memories were low in anxiety, painfulness and embarrassment but high in vividness. When the mean changes in scales were analyzed, changes were greatest in congruent odor condition. For only uniqueness scale, the congruent condition didn't make any difference but in the label condition there was a negative change. Therefore, by double cuing technique, results showed that odors were more potent retrieval cues. Moreover, as the incongruent odor condition was also included in the study, the possibility that odors may bias participants by the emotional potency they evoked was ruled out. However another hypothesis remained that couldn't be

ruled out by this experiment; the additive cue hypothesis. This hypothesis indicates that the difference may be due to a qualitatively different cue than verbal but congruent with it may make a difference so a second experiment was included by adding a visual cue congruent with the verbal cue. In the second experiment everything except the visual congruent cue was same with experiment one. But also, for analysis, the sentences in the description of memories were used. Each sentence were taken as a unit, and each additional information given participants as a response to second cue was coded as either new (providing new information) or irrelevant ( no new information). Results showed that, there were no differences among groups for cue one. For the responses to second cue, in the congruent odor group there were more “new” information than any other group. By this way, the additional cue hypothesis was ruled out because there was no significant difference in new information for the visual congruent odor. Thus, by these two experiments Chu and Downes (2002) showed that the efficiency of odors is based on their effect in retrieval process not in encoding process. In addition, complementary with Chu and Downes (2000), odor cued memories were shown to be more emotional, more detailed and older. Like Herz (2004), Chu and Downes (2002) speculated about the neuroanatomical character of olfactory area for the odor’s difference from semantic or visual cues.

This neuroanatomical explanation for odor’s efficacy was not empirically investigated until Herz, Elliansen, Beland and Souze (2004). In this study, the previous findings that indicate odors as more provocative and more emotional memory cues were investigated with its relation to amygdala activation. It was hypothesized that during the activation of odor cued memories amygdala should be especially activated in contrast to other cue types. So the aim of the study was to

conduct cross-modal autobiographical memory study using fmri and to test if the amygdala will be activated. For the experiment, five right-handed subjects were chosen from 12. Criteria were to have a pleasant and specific memory for the sight and smell of an odor. One to two months prior to test subjects were telephoned and were asked to identify a perfume whose sight and scent elicited a specific, pleasant, personal memory associated to a person, a place or event. Then subjects were asked a brief description of the memory and to rate how emotional they felt about it and how pleasant the memory was. (From 1-9 scale).. The control stimulus was an unmarketed generic perfume and it was same for all subjects. During scanning subjects were presented with experimental odor, control odor, experimental visual and control visual cues in three blocks of 16 trials. Sensory stimuli were presented in half of trials. During trials, subjects were asked if this evoked a memory and if they remained thinking on the same memory.

After scanning, in other room subjects evaluated all presented cues. First, they were asked to verify the stimulus was the same as the presented in the scanner. Then, they were asked what they have been thinking about the stimuli when presented and rated its emotionality in Likert scale. Also subjects were asked if they were reminded of the same memory each time the stimuli presented during scanning. Then, they evaluated how much they liked the stimuli and lastly they confirmed the experimental stimuli was the same as they reported in telephone. The results showed that when the participants had a subjective emotional experience of odor it correlated with the activation of amygdala during recall of memories. The experimental odor also elicited greater activation on amygdala-hippocampal complex than the personally nonsignificant odor. This finding confirms that the emotional activation by the odor is what makes difference not the odor artifact.

Thus, the previous findings indicating odor cue type is a more emotional than other cue types were once more confirmed here. In sum, the findings of Herz et. al. (2004) study suggests that odor memory cues elicit greater activation in the neural substrates of emotion than meaningful visual cues and non-meaningful odors.

The studies on odor cued autobiographical memories that have been mentioned before are all laboratory studies. Aggleton and Waskett (1999) aimed to investigate odors in real life events and used a Viking museum for this purpose. This museum was especially chosen because it had some unique features. In the museum, seven distinct odors were used to aid the sights and sounds in the museum. Moreover, in the first half of the museum the visitors were taken into museum by vehicles which provides a fixed route and uniformity in exposure to smells, sights or sounds. The participants were chosen from people who have visited the museum but there was inter individual variety in number of visits to museum, last visit to museum or age at the time of visit. These participants were grouped into three randomly. First group first received odors identical to the museum and after they were asked to complete a questionnaire about museum. Five seconds later they received the control set of odors that were not used in museum and were asked to complete the questionnaire second time. The second group was just the inverse of first group they received control set of odors first and the experiment set next. Third group was the control group and they completed the questionnaire without receiving any odor.

The mean scores from the questionnaires were computed. Although group one was slightly better than other groups in the initial test the difference was not significant. However when the improvement was taken into consideration, it was found that the greatest improvement was in the second group. This finding showed

that exposure to odors that were present in the museum improved the memory for the museum contents. As indicated before the inter-individual variability was present in the study but odors aid the memory even in subjects who visited the museum six years before the experiment. So, this study extended the notion of odor cue efficacy to real world settings and confirmed the odors' potency in evoking memories once more time.

Schifferstein and Cleiren (2005) investigated odor related memories compared to tactile, visual and auditory evoked memories as a part of a study on the assessment of sensory modality effects of product experiences. In the study, subjects were presented the six stimuli in visual, auditory, tactile or odor form. The stimuli were, permanent marker, a tennis ball, a deodorant spray, a boiled egg, a bag of crisps and a can of orange soft drink. The stimuli were chosen based on several criteria such as, having separate smell, feel, sound and appearance. In addition, the sensory stimuli could be presented separately and lastly the four stimuli had to originate from the product itself. After this, subjects were asked for associations to memories of events, people or places. These memories were rated on age, clarity, importance, emotionality and pleasantness. No difference for emotionality, pleasantness, feeling of going back to time event took place and age of memory was found. These results were opposed to previous findings of Chu and Downes (2000), Herz (2004) and Rubin et. al. (1984). However, Schifferstein and Cleiren (2005) argue that these differences may be due to instructions because in this study subjects were not asked for a specific, single and discrete event. Also, the participants were younger from Chu and Downes (2000) study which may explain the lack of finding that odors evoke older memories.

The most recent study that aimed to replicate and extend the previous findings on odor-evoked memories was by Goddard, Pring and Felmingham. In this study, the effect of cue modality was investigated with respect to the memories' speed of retrieval and specificity. For specificity, Williams and Dritschel (1992) hierarchical organization of memories based on theme was used. In this organization, the specific memories refer to unique events recalled in its context and contain a short period of time. In the absence of specific memories subjects may either can't recall any personal memory or they may recall general memories. General memories may be either categoric memories that include repeated events or extended memories that include extended periods of time. In another study (Williams, Hearly and Ellis, 1999) it is also found that visual imagery is an important factor in specificity of memory and as the visual imaginability of a cue increases the specificity of the memory increases. Thus, Goddard et. al. suggests that, verbal and visual cues would generate more specific memories and odors would lead to more categoric memories. For speed of retrieval, again based on the importance of visual imagery's and associations formed on visual imagery, odor evoked memories are expected to generate slower retrieval times. In addition, the vividness and age of memories were also investigated with respect to cue modality.

Odor, verbal and visual cues were used to elicit autobiographical memories. The cues selection was based on Chu and Downes (2000) and all the cues were high in familiarity. Each participant received the three modalities of cue but unlike Herz's (2002, 2004) double cuing technique, different items were presented thorough different modalities and the presentation was counterbalanced. The cue was given and participants were asked if they had any memory related to that cue. Moreover, they were also instructed to be quick and specific as possible. The age

of memories was asked and also the memories were rated on a vividness scale. For analysis, the given memories were coded as specific or general. General memories were further divided into extended memories and repeated memories. The age of memories were also categorized into three. First one included memories before 10 years of age (childhood), the second group was memories from last year (recent) and the third group was the memories that were in neither of them (others).

Results showed that, for odors fewer specific memories than verbal and visual cues were reported but there was no difference between verbal and visual cues for specificity. In the further analysis of odor memories, extended memories were found to be very rare so they were excluded from analysis but categoric memories were significantly given more for odor cues than for verbal and visual cues. In addition, tests showed that, retrieval to cue was most difficult for odor because failing to retrieve a memory was greatest for odors. Analysis of latencies also showed a significant main effect for modality that is for odor the response time was slowest but there was no difference for verbal and visual. The lowest percentage of memories for odor was recent compared to visual and verbal. Lastly, when the vividness of memories analyzed gender was found to make a significant difference and females reported more vivid memories. Also word cues were found to elicit more vivid memories than visual cues as the visual cues evoked more vivid memories than odor cues.

Overall, this study showed that odor evoked memories were more categoric and had slower response types. The age of odor evoked memories were partly shown to be older and the vividness of odor evoked memories were shown be less than visual and verbal cues. This study is different from previous studies in the sense that the double cuing technique was not used and memory selection was not

anchored with verbal cues. Goddard et. al. indicate that, this difference explains the different finding of this study from Chu and Downes (2002) that odors cues are better cues for autobiographical memories. In that study, odor cue generated memories were more detailed but Goddard et. al. showed that when the memory selection was also made by odor cues, it was less effective as fewer memories were evoked, and the latency for memory evocation was greater for odors. Lastly, as the memories for the odors were less vivid than visual and verbal cues, the interpretation of Proust phenomenon as odors evoked more vivid memories were shown to be wrong and Rubin et. al. (1984) finding was replicated.

### 1.3. Present Study

The main purpose of the present study is to compare the characteristics of memories evoked by visual, verbal and olfactory cues. Although there have been studies focusing on this issue, the lack of robust findings indicate the necessity of new studies with different sets of odors. Thus this study tries to expand the knowledge on odor evoked memories by using odors different from other studies.

More importantly, in all of previous studies individual scales were used for measurement. However, in this study Autobiographical Memory Questionnaire (Rubin et. al. 2003) is used to have a comprehensive picture of the characteristics of retrieved autobiographical memories. By this way, the main focuses of previous studies like emotionality, age and vividness could be investigated but also other questions included in the questionnaire could be applied to odor evoked memories.

One other important aspect of using this questionnaire is the possibility obtained for the investigation of metacognitive judgments. The component processes and metacognitive judgments are almost only studied verbal cued memories. However this study, explores the metacognitive judgments for odor

evoked memories and compares it with the memories evoked by verbal and visual cues.

To fulfill these purposes the present study consists of two experiments. The first one is aimed to replicate the findings of Laird's (1935) anecdotal study and a questionnaire is used which attempts to provide a descriptive picture of whether if some odors are more likely to elicit autobiographical memories. The second experiment compares different types of cues (odor, visual and verbal) in terms of several characteristics of memories they elicit by using Autobiographical Memory Questionnaire (Rubin et al, 2003) and investigates if there are differences in metacognitive judgments for these different cue types.

The method used in the second experiment was the single cue comparison method adopted first by Rubin et. al. (1984) and next by Goddard et. al. In this method, subjects receive cues from different modalities and they were asked to report a new memory for each of them. This method is unlike Herz et. al. (2002) double cuing method in which, the subjects always received the verbal cue first and re-evaluated the evoked memory by other cues. Although Herz et. al. (2002) indicate that without double cuing method it is not possible to discriminate whether the effect of cue was in selection or retrieval of memory, this technique was not useful here. The reason is that, written descriptions of memories were asked for each cue and ABQ was given after that.

## 2. STUDY ONE

The aim of study one was to examine whether it is common to have an odor evoked memory which was only investigated before by Laird (1935). Moreover, it also aimed to determine the frequency with which different odors evoke autobiographical memories.

## 3. METHOD

### 3.1. Participants

A total of 168 participants (116 women, 51 men) participated in this study. Mean age of participants was 20.33 with standard deviation 2.44. The participants were undergraduate students and received extra credit for their participation.

### 3.2. Materials and Procedure

The participants were tested in groups of approximately 20. Each participant was provided with a sheet of paper with the following question is typed: “Çevremizde karsilastigimiz kisi, nesne, görüntü, koku vb. bize bir anda yasamis oldugumuz bir olayi (bir animizi) çagristirabilir. Size böyle duydugunuz anda belirli bir aniyi çagristiran bir koku var mi? Varsa bu kokunun ne oldugunu yazip, hatirlattigi aniyi kisaca anlatir misiniz?” (The people, objects, images or odors around us may suddenly evoke a memory of an event. Do you have any particular odor that suddenly evoke a memory of yours. If yes, please indicate the odor and give a brief description of your memory) Additionally, the participant’s age and gender were asked.

#### 4. RESULTS

First of all, the memory descriptions were coded for if the participants had an odor that evoke memories for them. Of the 167 participants 92.2 % reported they had such an odor and 7.8 % reported they didn't. The odors participants indicated as evoking memories are presented in Table 2. The most frequent odor in the list was perfume with 32.2.% (n=49) of participants giving this odor. Although this odor has subdivisions like boyfriend's perfume, father's perfume all of them were coded as perfume. The next most frequent odor was mothball with 3.9 % (n=6) of participants. The rest of the odors were either given only by a few participants or only one participant.

Next, the descriptions were coded for the valence of memory (positive, negative, neutral), the specificity of memory (specific, general event, lifetime period) and what the memory refers to (person, place, activity). The results showed that most of the memories were mostly neutral (62.5 %), general event (54.6 %) and referred to a person (41.4 %). The results are presented in Tables 3 through 5. Memory descriptions were also coded for if the participants indicated their age of event for memories evoked. In 71.7 % (109) of 152 memory descriptions age was indicated and in 28.3 % (43) age was not indicated. From descriptions in which participants indicated their age at event, the mean of age was computed. The results showed that the mean age of events was 12.33 with the standard deviation of 5.17 and the median age was 13.50. The minimum age was three years old and the maximum age was 22 years old. The distribution of age of memories are presented in Figure 1. Lastly,

number of words used in descriptions were counted. Results showed that mean number of words were 32,67 and standard deviation was 17,01 with minimum 6 and maximum 84 number of words. Results are presented in Table 6.

## 5. DISCUSSION

This study aimed to provide a descriptive picture of memories evoked by odors. Participants were asked if they have any memory that is evoked whenever they sense a particular odor. This question was asked before by Laird (1935) it was found that eighty percent of men and ninety percent of women had such a memory and as far as we know after Laird (1934) for the first time in odor evoked autobiographical memory literature this question was investigated. In this study almost all of participants claimed they had a memory evoked by odors. This finding supported Laird (1935) and thus it can be concluded that it is common to have a memory evoked by odors.

The written descriptions participants gave were coded for several characteristics. First, which odors evoked memories were investigated. Perfume was found to be most common odor that evokes memory. The rest of odors were given only by a few participants. That means there is great inter individual variability with regard to odors to evoke memories. In addition, although perfume was most common each perfume response was referring a different perfume. Those were mostly perfumes of people that had a close relationship with the participants. From this finding it can be speculated that, the differing findings in odor-evoked memory studies may be due to this great variability in odors' potency in evoking memories for different people. Thus it can be concluded that to have full understanding of characteristics of odor evoked memories many studies should be conducted with different odor-stimuli sets.

Another point of interest was the emotionality of memories. Laird (1934) claimed that odor evoked memories were emotional however in the present study the highest percentage of memories were found to be neutral. This contradicted with the widely accepted belief that odors have a great potency in evoking emotional memories and the study of Herz and Cupchik (1992) where odors evoked memories were found to be highly emotional (either positive or negative).

The memory descriptions were also coded for the level of specificity. Most of memories were found to be general events than came specific memories and lastly life time periods. Conway (2000) argues that knowledge base is continuously reactive to the cues and the specificity of cue may lead to activation of different hierarchical level of memories. Based on cues ability, a specific memory can be activated. As the results of present study indicated when participants are not restricted to provide specific memories, the most common memories are general events so it can be concluded depending on Conway theory that odors are not efficient enough cues for evoking specific memories.

Lastly the age of memories were investigated. From the descriptions in which the age at event was indicated the mean age was computed as twelve. Taking into consideration that mean age of participants was twenty it can't be concluded that odor cues evoke old memories which contradicts the common belief that odors have potency in evoking old childhood memories.

## 6. EXPERIMENT 2

In study one the frequency of odors that evoke autobiographical memories was investigated and a descriptive account of odor evoked memories was obtained. In experiment two, the characteristics of memories evoked by odors and their difference from the memories evoked by verbal and visual cues was investigated. In this experiment, the most frequent odors indicated in the first experiment was used with the condition of having an easy to recognize pictorial representation, having a one word, commonly used name.

The aim of this experiment is to investigate characteristics of memories evoked by cues from different modalities. Rubin's Autobiographical Memory Questionnaire (AMQ) was used to investigate characteristics of memories. In none of the previous studies, a questionnaire was used and the evaluation of memories was conducted based on individual Likert type scales. By the use of AMQ, the memories could be analyzed in a more comprehensive way such that the metacognitive judgments (Rubin, 2003, 2005) in memories could be obtained from the odor evoked memories and these were compared with the verbally and visually evoked memories for the first time in literature.

## 7. METHOD

### 7.1. Participants

A total of 119 Bogaziçi university students (50 male, 69 female) from Bogaziçi University participated. They were given extra credit towards their introductory psychology grades.

### 7.2. Materials

#### 7.2.1. Cue items

Seven items were selected as cues for evoking autobiographical memories. They were raki (raki), mothball (naftalin), lavender (lavanta), coffee (kahve), strawberry (çilek), glue (uhu) and iodine (tendürdiyot). These items were provided to participants in three modalities which were odor, visual and verbal. Thus there were overall 21 cues (7 for each cue modality). The selection of items as the cues was partly based on the results obtained from experiment one. The most frequent reported odors as evoking memories in the experiment one was used. Also in selection, the other criteria was the familiarity of odors, as mostly the familiar odors were chosen like Rubin et. al. (1984) and the also possibility of odors to evoke childhood memories were taken into consideration so that iodine and glue was added. The odors included wide range of substances and half was edible and the other half non-edible. One other important criterion was that the items presented as odors should also be visually presentable and this presentation should

be easy to comprehend. Lastly, the ease of procurement was taken into consideration.

Odor cues were presented in plastic bottles, and odors were renewed in every 5 testing sessions to keep the odor fresh. The verbal cue was the name of the item and it was presented by verbal expression of cue . Lastly, the visual form was a picture of a prototypical item. These pictures were rated by 20 people in a pilot study on their typicality and if the item can be recognized.

### 7.2.2. Autobiographical Memory Questionnaire

Autobiographical Memory Questionnaire (AMQ) developed by Rubin, Schrauf and Greenberg (2003) was also used to evaluate memories evoked by cues. This questionnaire consists of 19 statements and all these statements except two of them have seven-point scales to be rated by participants. The questionnaire is intended for measuring several properties of autobiographical memory. The questionnaire was translated to Turkish and used in a Turkish society first by Gülgöz and Rubin (2001). In this study 16 statements were used from Autobiographical Memory Questionnaire. The properties and the statements used to measure them are given in Table 1. In addition five more memory rating scales were added to AMQ which were vividness, emotionality at the time of event, emotionality now, valence of memory, the date the event was thought of last time. These are also presented in Table 1. The autobiographical memory questionnaire is also presented in Appendix A.

### 7.2.3. Odor naming scale

This scale was prepared to ask participants if they could name the odor. In addition to that for each odor, a seven point scale with 1 “very bad smell” and 7 “very nice smell” is added. The scale is presented in Appendix B.

### 7.3. Procedure

All participants were tested individually. The participants were taken into the laboratory at Bogaziçi University. The laboratory was aired before the participant entered to prevent the mixture of odors. First, the participants were informed that this study was about autobiographical memories and that they would receive cues and would report if they have any specific memories related to that cue. Then, they were given the consent forms.

There were three different cue modalities and each individual was assigned randomly to one modality group. Each participants received all seven cue items and the order of cue items were randomly chosen.

In odor condition, the plastic bottle was opened and the participant was asked to sniff. Then, he/she was asked if any specific memory evokes from this cue. If the participants answered yes, he/she was asked to tell a brief description of memory. The description were recorded by a digital voice recorder. The latencies in the giving the description were also recorded. After the description, participants were asked to rate the memory by Autobiographical Memory Questionnaire. The additional rating scales were attached to AMQ. After all odors were presented participants were asked to sniff odors one more time and they were given the odor naming scale.

For visual cue everything was same except, a colored photograph of the item was presented instead of odor and participants were asked if this evoked any memory. Then the same rating process were completed the memories but the odor naming scale was not presented. Lastly, for verbal cue, the cue was presented verbally and all other processes were same.

## 8. RESULTS

In the literature of autobiographical odor memory, there have been different findings with regard to effectiveness of odors and words in eliciting autobiographical memories. While in a recent study Willander and Larsson (2006) didn't find any significant difference in number of memories evoked by odors and words, in Chu and Downes (2000) equal number of memories were obtained only when the number of participants in odor condition was twice the number of participants in verbal condition. This difference was also present in Herz and Cupchik (1992) study in which hit rate was as low as 25%. Thus, in the analysis first the number of memories evoked, for each participants as a function of cue type was calculated. A one way ANOVA with cue type (verbal, visual, olfactory) as a between-groups factor was used for analysis. The results showed that out of 7 possible memories, similar numbers of memories were generated for words ( $M = 5.07$ ,  $SD = 1.26$ ), pictures ( $M = 5.17$ ,  $SD = 1.39$ ) and odors ( $M = 4.95$ ,  $SD = 1.40$ ) [ $F(2, 116) = .26$ ,  $p > .05$ ].

Next, to examine if different cue items had different effectiveness in evoking memories for each cue type the number of memories given for each cue item (raki, mothball, lavender, coffee, strawberry, glue, iodine) and the percentage of participants generated memories for items was computed. Results are displayed in Table 7. To analyze, separate one way ANOVA's for each cue item with cue type as between subject factor were conducted and for none of the cue items a significant main effect was found (all  $ps > .05$ ) which showed that equal number of memories were evoked in different cue modalities for each cue. When the effectiveness of cue

items' in evoking memories were investigated it was found that raki was most effective with 87.1 % of participants giving a memory for this item. It was followed by coffee (84.9 %), iodine (82.5 %), glue (75.6 %), strawberry (71.5 %), lavender (57.9 %) and mothball (50.2 %).

### 8.1. Memory ratings

One of the main purpose of the studies on odor evoked autobiographical memories was to investigate experiential characteristics of these memories and its comparison with other cue types such as words or pictures. Generally odor evoked memories were found to be less thought and spoken of (Rubin et. al., 1984; Willander and Larsson, 2006) and emotional (Rubin et. al., 1984, Herz and Cupchik, 1992; Chu and Downes, 2002; Herz and Schooler, 2002; 2004). Also vividness (Herz and Cupchik, 1992; Chu and Downes, 2002) and feeling of brought back in time that is mentally traveling to original experience (Herz and Schooler, 2004) were found be significantly different for odor evoked memories but not all studies established this significant differences. To investigate this contradictory findings and also responses to questions in AMQ that haven't been asked before in autobiographical odor memory literature, the difference in ratings for odor, verbal and visual cues were analyzed.

As participants were given the Autobiographical Memory Questionnaire and five additional scales for each cue item, before analyzing responses to memory ratings mean scores of seven cue items were computed for each memory ratings. A total of 21 mean scores which included emotionality at the time of event, emotionality now, vividness, brought back in time, reliving and age at the time of event were obtained. All measures of memory are presented in Table 1. For analysis of these scores 2 (gender) x 3 (cue type: verbal, visual, olfactory) multivariate

ANOVA was used. Result showed no main effect of cue type for any memory ratings. ( $p < .05$ ). All means and standard deviations are presented in Table 8. Only the odor question that asked if they could remember the odors that were present in the time of event revealed a significant result between cue types as expected. [ $F(2,199) = 22.795, p < .001$ ]. Post hoc analysis confirmed that in odor condition participants gave higher ratings than verbal and visual condition. There was no difference between verbal and visual condition. On the other hand, for measures in words and narrative, ratings for verbal cue and for see measure, ratings for visual cue was not higher (all  $p > .05$ ). However, despite no main effect of cue type, for touch ratings post hoc analysis showed a significant difference between odor and verbal conditions ( $p = .04$ ). There was no significant difference between olfactory and visual, visual and verbal conditions.

Laird (1935) in his anecdotal study indicated that women had more emotional and vivid memories than men but no statistical analysis were conducted. This finding was later investigated by Herz and Cupchik (1992) statistically. They found significant differences in memory clarity and emotional descriptors where in both women had higher scores. However Herz and Schooler (2004) failed to replicate this finding. Because of these contradictory findings effects of gender in memory ratings were investigated in this study and gender was included as a between subject factor in ANOVA. All means and standard deviations for gender are presented in Table 8. Results showed that, there were significant differences for see (if they could see the images at the time of event at their mind now) and story (if they remembered as a coherent story) ratings, [ $F(1,119) = 6.14, p = .015$ ] and [ $F(1,119) = 4.08, p = .04$ ] respectively. Females had higher ratings for both questions. In addition feel question approached significance [ $F(1,119) = 3.69, p = .057$ ]. No other rating revealed a

significant result for gender. Moreover there was a significant gender x cue type interaction for remember know rating [ $F(2,119)= 3.61, p=.03$ ]. Observation of means showed this effect was obtained because males had higher remember-know ratings for verbal condition whereas females had higher ratings for visual and odor conditions.

## 8.2. Age and Novelty

Since Proust there had been a belief that olfactory cues had a greater potency in evoking older memories. This belief was first tested by Rubin et al. (1984) but no significant difference was found between odor, verbal and visual cues for the age of memories. Later Chu and Downes (2000) and Willander and Larsson (2006) replicated Rubin study with older participants and found significant difference in age of memories for different cue types. In this study age was included in the analysis for the replication of Rubin et. al. (1984) and as indicated before no significant difference was obtained. But to have a comprehensive understanding the age of participant at the time of event was also further analyzed. The age at the time of event was transformed into three different variables. These were the proportion of memories from 0-9 ages, proportion of memories from 10-19 ages and the proportion of memories from 20-29 ages. The proportion of memories from 0-9 ages, 10-19 ages and 20-29 ages for cue modalities are shown in Figure 2. These three variables were analyzed 2 (gender) x 3 (cue type: verbal, visual, olfactory) MANOVA. The means and standard deviations are given in Table 8. No main effect of cue type and gender was obtained ( $p>.05$ ) but there was significant gender x cue type interaction for proportion of memories from 10-19 ages. Observation of means showed while in females highest proportion was for verbal than olfactory and visual, in males had highest proportion was in olfactory than visual and lastly verbal.

In addition, to investigate how different cue items effect the age of memories they evoked the mean age at the time of event for each cue item was calculated. Than separate one way ANOVA's were performed for each cue item with the cue type as a between subject factor. All means and standard deviations are presented in Table 9. Results showed that only for raki there was a significant main effect of cue type [F(2,100)= 4.124, p=.019]. Additional Tukey post-hoc test showed that this effect was obtained due to difference between visual and olfactory cues (means 18.24 and 15.36 respectively) which shows that for raki odor evoked memories are older than verbally evoked memories.

Rubin et al. (1984) found that odor evoked memories were less thought and less spoken of. Thus for investigating this finding, in the present study participants were asked to rate how often they think of the event and in addition they were asked to date the last time they thought of this event. The question when participants recalled the event last time was coded as number of days for multivariate analysis and no significant result was obtained as mentioned before. But, for excluding the possibility high variance for insignificant results logarithms were taken for each seven cue items and means for these logarithms were computed. This new variable was examined by one way ANOVA as cue type between subject factor. Again no significant difference was obtained [F (2,119)= 1.137, p>.05],(verbal mean 1.94 and SD 0.56; visual mean 1.82 and SD 0.70 and odor mean 2.03 and SD 0.55).

In addition, some participants indicated that they haven't recalled the memory before when they were asked to date last time they recalled the event. To examine if there was difference in never recalled memories between cue types a new variable which included the proportion of never recalled memories to all given memories for each participants was created. In Rubin et al. (1984) study the same procedure was

followed but proportions were calculated from the how many times did you think and talked about the event” questions because of high number of missing data for “when was the last time you thought of event” question. As in this study there were no missing data for “when was the last time you thought of event” question, this question was used. This new variable was named as novel memories following Rubin et. al, (1984). 28 % of verbal cue evoked, 21% of visual cue evoked and 25% of olfactory cue evoked memories were novel. Differences in novel memories for different cue types were analyzed by one way ANOVA as cue type between subject factor. No significant results were obtained [ $F(2,119) = .714, p > .05$ ].

### 8.3. Cue Items

To determine whether the specific memory items influenced the memory rating responses separate repeated measures of ANOVAs with cue item (raki, mothball, lavender, coffee, strawberry, glue, iodine) as factors for 21 questions. Table 10 shows means and standard deviations of each cue item for memory variables. Results showed a significant main effect for Reliving [ $F(6,102) = 2.87, p = 0.012$ ], hear [ $F(6,102) = 3.62, p = .003$ ], talk [ $F(6,102) = 3.25, p = 0.006$ ], feel [ $F(6,102) = 4.229, p < .001$ ], remember-know [ $F(6,102) = 3.203, p = .006$ ], importance [ $F(6,102) = 3.135, p = .007$ ], real/imagine [ $F(6,102) = 2.585, p = .023$ ], frequency [ $F(6,102) = 5.598, p < .001$ ], age [ $F(6,102) = 5.462, p < .001$ ], emotion then [ $F(6,102) = 4.775, p < .001$ ], emotion now [ $F(6,102) = 2.659, p = .019$ ], vividness [ $F(6,102) = 5.226, p < .001$ ] and valence [ $F(6,102) = 2.667, p = .0019$ ]. In addition, post-hoc Bonferroni analysis were conducted to see which cue items differed from each other for each 21 questions. Table 11 shows cue items that significantly differ from each other and their significance levels. This findings indicated that different cue items had different effects on memory ratings.

#### 8.4. Cue Naming

Relationship between cue naming and memory evocation for odors was discussed in Herz and Cupchik (1992) study. The correlation between odor naming and odor-memory evocation was found to be significant. Moreover, it was found that memories evoked most often when the odor was named but also interestingly 32% of memories were found to evoked without the odor could be named. It was concluded that “semantic association for an odor was not a necessary pre-condition in order for a memory to be evoked” (pg. 525). In this study too, participants were asked if they could name the odor. They either named the odor or indicated they couldn't name. The answers were also coded as right or wrong. To see if the same finding could be reached from this data, number and percentage of memories obtained from named and unnamed odors were calculated. Results showed that a total of 201 memories were obtained for odor condition. 80.6 % of them (n=162) were named correctly, 15.9 % of them (n=32) were named incorrectly and for 3.5 % of them (n=7) participants responded as they couldn't name the odor. Which supported Herz and Cupchik (1992) that semantic association is not necessary for memory evocation. Moreover, the same calculation was done for each cue item too and percentages of memories obtained by correct naming, incorrect naming and without naming condition for each item was calculated. Although in each cue item highest percentage of memories were obtained when the cue was correctly named, 4.9% of memories for raki, 7.3% for lavender and 2.43 % of memories for glue and iodine were evoked without any naming. Table 12 show numbers and percents of odors named and memories given for each condition.

Moreover, in order to exclude any possible effects of not naming the odor or naming it wrongly a new data set was created by only including correctly named

odors from odor condition and the other memories from verbal and visual conditions. Like in original data, mean scores for seven cue items were computed for each memory ratings. A total of 21 mean scores were obtained. For analysis, 2 (gender) x 3 (cue type: verbal, visual, olfactory) multivariate ANOVA was used. All means and standard deviations for memory ratings are presented in table 13.

Again, no main effect of cue type on memory ratings was obtained. Only the odor questions revealed a significant difference [ $F(2,119) = 19.992, p < .001$ ]. However additional post hoc analysis revealed a significant difference in touch ratings between verbal and olfactory condition ( $p=.012$ ). No other significant difference was obtained.

For gender a main effect was obtained only for see question [ $F(2,119) = 5.80, p = .018$ ]. Mean observations showed that females had higher ratings for see questions. In this new data set narrative question only approached significance ( $p=.058$ ). On the other hand gender x cue type interactions showed significant results for remember-know ratings [ $F(2,119) = 3.87, p = .024$ ], travel back in time ratings [ $F(2,119) = 3.29, p = .041$ ] and number of days before the event was last recalled [ $F(2,119) = 3.32, p = .04$ ]. The reason for interaction in travel back in time was that females had higher ratings for visual and olfactory conditions than verbal condition whereas males ratings for verbal and visual conditions were higher than olfactory condition. For remember-know ratings females' visual and olfactory ratings were higher than verbal ratings but males' ratings in verbal condition was higher than visual and olfactory conditions. For number of days before the event was last recalled females remembered the events for visual and olfactory conditions in closer time than verbal condition but males remembered the verbal conditions sooner than visual and olfactory conditions.

## 8.5. Metacognitive Judgments

Recollection and belief is known to be basic features of autobiographical memories (Brewer, 1996). In a previous study on autobiographical memories it was shown that these metacognitive judgments could be predicted from component processes of autobiographical memories (Rubin, Schrauf and Greenberg, 2003). However only verbal cues were used to evoke autobiographical memories and metacognitive judgments were not investigated for olfactory cues. Thus in attempt to answer whether and how measures of belief and recollection would be predicted by component processes in odor evoked memories multiple regression analysis were conducted separately for verbal, visual and olfactory cues.

Results of multiple regression analysis for autobiographical memories are given in Table 14. From overall pattern it is apparent that metacognitive judgments are explained by different set of variables for different cue types. First of all, a measure of recollection reliving is predicted by emotion for verbal cue, by see for visual cue and by emotion and touch for olfactory cue.. The other measure of recollection back in time is predicted by talk, emotion and negatively contributing frequency for verbal cue; by emotion\_for visual cue and by touch for olfactory cue.

Remember/know is predicted by none of variables for verbal cue; by talk, touch, story and negatively contributing frequency for visual cue and by emotion and setting for olfactory cue. Lastly a measure of belief real/imagine is predicted by setting and negatively contributing in words for verbal cue. However none of variables can predict real/imagine for olfactory and visual cues.

## 9. CONCLUSIONS AND DISCUSSION

The main aim of the study was to compare characteristics of memories evoked by visual, verbal and olfactory cues. In the literature of odor evoked memories this comparison was done by individual scales however in this study a well established and frequently used scale measuring phenomenological characteristics of autobiographical memories, Rubin's Autobiographical Memory Questionnaire was used. By this way, the main points of interest like emotionality, vividness, age and novelty of memories were once more investigated but also other measures included in the AMQ were applied to odor-evoked memories for the first time. Moreover, the metacognitive judgments in odor-evoked memories were investigated and they were compared with memories evoked by verbal and visual cues.

Overall, results showed that there were no differences in characteristics of memories evoked by verbal, visual and olfactory cues. Only the touch ratings were significantly higher for odor evoked memories. The age at the event and novelty also didn't differ among cue types. Although gender didn't have a main effect there was interaction in remember know ratings in which males had higher remember-know ratings for verbal condition whereas females had higher ratings for visual and odor conditions. When the naming of odors and evocation of memory was investigated, it was found that a small percentage of memories were evoked without participants being able to name the odor. This confirmed that verbal association was not a precondition for odors to evoke memories. Lastly, investigation of metacognitive

judgments showed that each cue type had different contributing variables for different judgments.

### 9.1. Memory characteristics

In the previous studies of odor-evoked memories the main topics of interest were emotionality, vividness, feeling of brought back in time and age. In the present study, the questions measuring these characteristics were included in AMQ.

Emotionality was measured by questions “emotionality at the time of event”, “emotionality now”, “I can feel the emotions now that I felt back than” and the valance of memories. The statistical analysis conducted on these measures revealed insignificant results. In other words, results showed that there were no differences among olfactory, verbal and visual cued memories in terms of how emotional they were. This finding was in line with Rubin et. al. (1984) where no consistent difference could be found. However later studies found significant differences (Chu and Downes, 2002; Herz ad Cupchik, 1992; Herz and Schooler, 2002; 2004) but in these studies the method used was different from both Rubin et. al (1984) and the present study. Single cuing method used in this study required random assignation of participants to one of the cue-type groups and they received only one of the cue types. In other studies, double cuing method was used where the participants first received verbal cue and recollected memories from this cue than they received the other type of cue and evaluated memory again. The only study that used the single cuing method after Rubin et. al. (1984) also found that picture evoked memories were more emotional and there were no differences between odor and verbal cued memories (Willander and Larsson, 2006). Thus, it can be argued that cuing method has an important affect in emotionality of memories and it can be concluded that

when participants not only rate but also choose memories by odor cues the evoked memories are in same emotionality level with memories evoked by verbal cues.

The other measures investigated in literature are feeling of brought back in time, vividness and specificity. Those measures derive from Proust's description of his memory. In the present study, specificity was not investigated as the participants were explicitly asked to report specific memories. However, memories' level of feeling of brought back and vividness were found not be differing among different cue types. These findings were again in line with Rubin et al. (1984). There were several studies that found significant differences for brought back (Herz and Schooler, 2002; 2004 and Willander and Larsson, 2006) and vividness (Herz and Cupchik, 1992) but also others failed in replicating these differences. From the contradictory findings in literature and the finding of present study, it can be concluded that odor evoked memories are not more vivid and they don't have a higher feeling of brought back. One plausible explanation for different findings may be the different odor-sets used however to have full understanding new studies with different cue sets is necessary.

Aside from previously studied characteristics, with the used of AMQ other measures that haven't been applied before to odor evoked memories were also investigated. For none of the measures like if participants "can see the event in their mind", "can hear the event in their mind", "feel like they are reliving the event" or "think the event is important" a significant difference between odor, verbal and visual cued memories could be found. Only for touch rating, there was a significant difference between olfactory and verbal cued memories where for odor evoked memories touch ratings were higher. This may indicate that a secondary cue like odor is encoded in the memory, the other secondary cues like touch is also encoded.

Gender differences were also investigated in the present study. In his anecdotal study Laird indicated that women had more vivid and emotional memories than men. This difference was later confirmed by Herz and Cupchik (1992) but Herz and Schooler (2004) failed to replicate the finding. In the present study, results showed a significant difference for see and story ratings where women had higher ratings for both of them but this difference was for all memories regardless of cue types. When the cue type gender relation was investigated the results showed that there was a significant interaction for remember know ratings. Males had higher remember-know ratings for verbal condition whereas females had higher ratings for visual and odor conditions. This difference contradicts previous studies where gender differences in odor evoked memories were found in emotionality (Laird, 1935; Herz and Cupchik, 1992) and vividness (Laird, 1935). As only a few studies investigated gender differences and remember know ratings were not included as a measure in these studies, it can be concluded that to have a full understanding of gender differences on memories evoked by different cue types further research focusing not only in emotionality but also in other measures like remember-know ratings is necessary.

## 9.2. Age of memories

Age of odor evoked memories was another topic that attained the attention of researchers. The results of the present study showed that there were no differences among cue types for the age of memories they evoked. First, the age of memories were compared than the proportion of memories from 0-9 ages, 10-19 ages and 20-29 ages were computed. In the analysis of proportions, again no differences were found. For all cue types most of the memories came from 10-19 ages. These differences were in line with Rubin et. al.(1984). In that study, university students

were used as participants and mean age was around twenty years old. When this study was replicated by older participants (Chu and Downes, 2000; Willander and Larsson, 2006) significant differences for the age of memories among odor, verbal and visual cues were found. The finding of present study confirms that when age of memories are compared in younger participants different cue types don't reveal significant different differences. Those differences can only be reached by using older participants. On the other hand, the only study concluding odor evoked memories were old with younger participants was Herz and Cupchik (1992) but in that study no comparisons were done between different cue types. Present findings contradict with this study because regardless of comparison, the mean age of odor evoked memories was fourteen. Taking this into consideration it can be concluded that odor evoked memories are not old and as indicated in Chu and Downes (2000) significant differences among cue types can only be revealed by using older participants.

In Rubin et. al.(1984) study the only significant differences between memories evoked by odor, verbal and visual cues were “how often the memory was thought and spoken of”. In the present study, participants were asked the same questions but the results failed show this difference. Memories for all cue types were thought and spoken of equally. Moreover, in Rubin et. al.(1984) a variable named “novel memories” was created from the “how often the memory was thought and spoken of” question. The number of never recalled memories were computed and they were compared among different cue types. In here this new variable was computed from the “when was the last time you thought of the event”. The percentage of never recalled memories were computed for all cue types but the analysis of this new variable also revealed insignificant results. A plausible

explanation for the lack of differences would be the odor set used. Rubin et. al. (1984) claims that the reason for significant differences in novelty of memories can be that odor cues may be encountered less frequently than verbal and visual cues despite the fact that the odors used in the study are frequently used ones. However, in the present study just the opposite condition is present. The half of the odors used are frequently used (coffee, strawberry) while the others are hard to encounter frequently (mothball, lavender). Despite that, still no difference in novelty was found. Therefore, it may be concluded that regardless of the odor set used the odor-evoked memories are not more novel than memories evoked by verbal and visual cues.

### 9.3. Cue naming

In Herz and Cupchik (1992) the relationship between naming the odors and potency of odors in evoking memories was investigated. Results indicated that naming of odors was not a necessary precondition for memories to evoke as one third of memories were evoked without verbal labels. Findings from the present study also confirmed that verbal labeling was not a precondition. Still the highest percentage of memories came when participants could name the odor but the presence of memories without verbal labeling showed that recollection was not based on verbal labels.

### 9.4. Metacognitive judgments

This was the first study to apply metacognitive judgments to odor-evoked memories. Results showed that the emotion was the most important variable that contributed most of metacognitive judgments. More importantly, it was found that for different cue types different variables contributed metacognitive judgments.

For reliving, while emotion was the only predictor for verbal cues, touch contributed as much as emotion for odor evoked memories. In visual cued memories, the only significant contributor was see.

Remember know judgments showed an interesting pattern. For each cue type, totally different variables made contribution. First of all, remember-know judgments for verbal cues memories were not predicted by any of variables. On the other hand, four variables (talk, touch, story and frequency) contributed to visual cued memories. Odor evoked memories were predicted by emotion and setting variables.

Also for back in time, different variables contributed to different cue types. Verbal cued memories' back in time judgment was predicted by talk and emotion, visual cued memories' by emotion and odor evoked memories' by touch.

Lastly, for real/imagine judgment while setting and in words contributed verbal cued memories, none of variables contributed to visual and olfactory memories.

Overall, these findings indicate that different variables are contributing to metacognitive judgments in memories evoked by different cue types. This difference is evident especially on remember/know judgment in which each cue type has different contributing variables. Moreover, it can be concluded that emotion and touch variables are the most important ones for odor-evoked memories as both contribute to two out of four judgments. Lastly, as hear, odor and importance doesn't contribute to any of judgments it can be argued that they don't have any influence in metacognitive judgments. As this is the first time metacognitive judgments are investigated in odor-evoked memories, further research is necessary for closer examination.

## 9.5. Conclusion

From this study, it can be concluded that, there no differences between odor, verbal and visual cues in terms of characteristics of memories they evoked. Aside from previously studied measures like vividness, age, emotionality and brought back

in time; the measures included in AMQ and applied to odor evoked memories for the first time shows no differences among cue types. The only significant difference between these cue types is in the metacognitive judgments. Each cue type has different contributing variables in different judgments. Thus, it can be argued that for odor, verbal and visual cues, different modalities has different levels of affect.

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## 11. TABLES

Table 1: The Autobiographical Memory Variables and the Turkish and English Versions of Statements Measuring Them

<i>Variable</i>	<i>Turkish statement</i>	<i>English statement</i>
Reliving	Olayı hatırladığımda olayı yeniden yaşıyormuş gibi hissediyorum	As I remember the event, I feel as though I am reliving the original event
Hear	Olayı hatırladığımda, olay anındaki sesleri zihnimde işitebiliyorum	As I remember the event, I can hear it in my mind
See	Olayı hatırlarken, olay anındaki görüntüleri zihnimde görebiliyorum	As I remember the event, I can see it in my mind
Talk	Olayı hatırlarken, olay anında benim ya da başka insanların konuştuğunu hatırlıyorum	As I remember the event, I or other people talking
Emotion	Olayı hatırlarken, olay anındaki duygularımı şimdi de hissediyorum	As I remember the event, I can feel now the emotions that I felt then
Setting	Olayı hatırlarken, olayın geçtiği yeri hatırlayabiliyorum	As I remember the event, I can recall the setting where it occurred
Odor	Olayı hatırlarken, olay anındaki koku ya da kokuları şimdi de hatırlıyorum	As I remember the event,
Touch	Olayı hatırlarken, temas ettiğim şeylerin yumusaklık/sertlik ya da sıcaklık soğukluk gibi dokunsal niteliklerini hatırlıyorum	As I remember the event,
Remember/know	İnsanlar bazı olayların detaylarını hatırlamasalar da başlarından geçtiklerini bilirler. Ben animi hatırlarken, bu olayın basımdan geçtiğini bilmekten öte, onu gerçekten hatırlayabiliyorum	Sometimes people know something happened to them without being able to actually remember it. I can actually remember it rather than just knowing that it happened
In words	Olay aklıma daha çok kelimeler halinde geliyor	As I remember the event, it comes to me in words
Travel back	Olayı hatırlarken, olayın olduğu zamana geri döndüğümü ve olayı dışarıdan seyreden biri olarak değil olayın içinde olan, olaya doğrudan katılan biri olduğumu hissediyorum	As I remember the event, I feel that I travel back to the time it happened, that I am a subject in it again, rather than an outside observer tied to the present
Story	Olayı hatırlarken, olay aklıma yalnızca bir durum, gözlem ya da sahne şeklinde parça parça değil; sözcükler ya da resimlerden oluşan bütün bir hikaye ya da olay olarak geliyor	As I remember the event, it comes to me in words or pictures as a coherent story or episode and not as an isolated fact, observation, or scene
Importance	Bu olay bana bir mesaj verdiği ya da yaşamımda kritik bir zamanı ya da dönüm noktasını simgelediği için benim için önemli bir anıdır	This memory is significant for my life because it imparts an important message for me or represents an anchor, critical juncture, or a turning point
Real/imagine	Bu olayın gerçekten hatırladığım şekilde gerçekleştiğine ve olmamış herhangi bir şeyi hayal etmediğime ya da kurmadığıma inanıyorum	I believe the event in my memory really occurred in the way I remember it and that I have not imagined or fabricated anything that didn't occur

Table 1 (continued)

<i>Variable</i>	<i>Turkish statement</i>	<i>English statement</i>
Frequency	Bu olay oldugundan beri, bu olay hakkında dsndm ya da konustum	Since it happened, I have thought or talked about this event
Age at event	Olayın gerekleştėđi tarih	The date of event
Emotion then	Olay gerekleştėđi sırada hissettėđim duygular	My feelings at the time of event
Emotion now	Olayı şimdi hatırlarken hissettėđim duygularım	My feelings now as I remember the event
Vividness	Bu olayı ok canlı bėimde animsiyorum	I vividly remember the event
Valence	Bu olay sizin iin ne kadar olumlu/olumsuz	The degree the event is positive/negative for you
Last time recalled	Olayı en son hatırladėđım zaman	The last time I recalled the event

Table 2. List of Odors That Evoke Memories

Odor list	Frequency	Percent
Parfüm	49	32,2
Naftalin	6	3,9
Kömür	4	2,6
Sabun	4	2,6
Yemek	4	2,6
Benzin	3	2,0
Ten	3	2,0
Yasemin	3	2,0
Çiçek	2	1,3
Çikolata	2	1,3
Hastane	2	1,3
Islak beton	2	1,3
Kolonya	2	1,3
Toprak	2	1,3
Ahir	1	0,7
Amonyak	1	0,7
Anne ev	1	0,7
Araba	1	0,7
Biber dolma	1	0,7
Cam	1	0,7
Cam sakizi	1	0,7
Çikolatalı puding	1	0,7
Çilek	1	0,7
Çim	1	0,7
Cıla	1	0,7
Defter	1	0,7
Demir	1	0,7
Deniz	1	0,7
Duman	1	0,7
Evim	1	0,7
Ev kokusu	1	0,7
Fasulye	1	0,7
Gülsuyu	1	0,7
Günes yağı	1	0,7
Havasız	1	0,7
İlaç	1	0,7
Is	1	0,7
Jöle	1	0,7
Karnibahar	1	0,7
Kayak takimi	1	0,7
Kek	1	0,7
Kitap	1	0,7
Kızarmış ekmek	1	0,7
Köfte	1	0,7

Table 2 (continued)

Odor list	Frequency	Percent
Kokoreç	1	0.7
Krem	1	0.7
Küf	1	0.7
Kurabiye	1	0.7
Kuru fasulye	1	0.7
Kusmuk	1	0.7
Lavanta	1	0.7
Limon	1	0.7
Marihuana	1	0.7
Muzlu puding	1	0.7
Narkoz	1	0.7
Nescafe	1	0.7
Non defined	1	0.7
Omo	1	0.7
Papatya	1	0.7
Kisisel	1	0.7
Pide	1	0.7
Portakalli sabun	1	0.7
Sakiz	1	0.7
Sampuan	1	0.7
Sigara	1	0.7
Sinema	1	0.7
Tavuk	1	0.7
Tekila	1	0.7
Tereyagi	1	0.7
Viski	1	0.7
Waffle	1	0.7
Yagmur	1	0.7
Yanik	1	0.7
Yanik yemek	1	0.7
Yiyecek	1	0.7
Yosun	1	0.7
Yumos	1	0.7
Zakkum	1	0.7
<b>Total</b>	<b>152</b>	<b>100</b>

Table 3 Emotional Valence of Memories

	N	%
Positive	24	15.8
Neutral	95	62.5
Negative	33	21.7
Total	152	100

Table 4. Specificity of Memories

	N	%
Specific	49	32.2
General event	83	54.6
Life time period	20	13.2
Total	152	100

Table 5. What Memories Refers To

			Total	
	N	%	N	%
Person	37	24.3	63	41.44
Place	15	9.9	35	23.02
Activity	32	21.1	62	40.78
Person & place	5	3.3		
Person & activity	15	9.9		
Place & activity	9	5.9		
All	6	3.9		
Other	33	21.7		
Total	152	100		

Table 6 Descriptive for Age at Event and Number of Words in Descriptions

	N	Minimum	Maximum	Mean	SD
Age at event	42	3.00	22.00	12.33	5.17
Number of words	152	6.00	84.00	32.67	17.01

**Table 7. Number of Memories Given for Each Cue Item**

		Verbal	Visual	Olfactory	Overall
Raki	Yes (N,%)	36 (92.3)	33 (84.6)	33 (84.6)	34 (87.1)
	No (N,%)	3 (7.7)	6 (15.4)	8 (29.5)	5.6 (12.9)
Mothball	Yes (N,%)	18 (46.2)	16 (41.0)	26 (63.4)	20 (50.2)
	No (N,%)	21 (53.8)	23 (59.0)	15 (36.6)	19.6 (49.8)
Lavender	Yes (N,%)	22 (56.4)	22 (56.4)	25 (61.0)	23 (57.9)
	No (N,%)	17 (43.6)	17 (43.6)	16 (39.0)	16.6 (42.1)
Coffee	Yes (N,%)	35 (89.7)	33 (84.6)	33 (80.5)	33.6 (84.9)
	No (N,%)	4 (10.3)	6 (15.4)	8 (19.5)	6 (15.1)
Strawberry	Yes (N,%)	29 (74.4)	29 (74.4)	27 (65.9)	28.3 (71.5)
	No (N,%)	10 (25.6)	10 (25.6)	14 (34.1)	11.3 (28.5)
Glue	Yes (N,%)	27 (69.2)	33 (84.6)	30 (73.2)	30 (75.6)
	No (N,%)	12 (30.8)	6 (15.4)	11 (26.8)	9.6 (24.4)
Iodine	Yes (N,%)	32 (82.1)	36 (92.3)	30 (73.2)	32.6 (72.5)
	No (N,%)	7 (17.9)	3 (7.7)	11 (26.8)	7 (27.5)

The numbers in parenthesis indicate the percentage of participants that gave memory for an item in the particular cue modality. For example for raki in verbal condition 92.3 % of participants and in visual condition 84.6 % of participants gave memory.

Table 8. Descriptives for MANOVA

		Verbal		Visual		Olfactory		Overall	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Reliving	Female	4.95	1.09	5.28	.85	5.24	.17	5.15	1.05
	Male	1.94	1.02	4.83	.97	4.95	.79	4.90	.91
	Total	4.94	1.05	5.07	.92	5.12	1.03	5.05	1.00
Hear	Female	3.99	1.41	4.15	1.18	4.32	1.21	4.16	1.27
	Male	4.45	.97	3.92	.93	3.82	1.17	4.05	1.04
	Total	4.17	1.27	4.05	1.07	4.12	1.21	4.11	1.17
See	Female	5.35	.93	5.67	.64	5.65	.74	5.55	.79
	Male	5.27	.84	5.04	1.07	5.23	.61	5.17	.86
	Total	5.32	.89	5.38	.91	5.48	.72	5.39	.84
Talk	Female	4.68	1.24	4.78	1.20	4.60	1.24	4.69	1.21
	Male	4.87	1.14	4.31	1.08	4.07	1.17	4.40	1.15
	Total	4.76	1.19	4.56	1.16	4.38	1.23	4.56	1.19
Emotion	Female	4.49	1.35	4.92	.90	5.03	.98	4.81	1.11
	Male	4.60	.89	4.29	.89	4.45	.86	4.44	.87
	Total	4.53	1.18	4.63	.94	4.79	.97	4.65	1.03
Setting	Female	6.05	.73	6.35	.65	6.16	.77	6.18	.72
	Male	6.17	.73	6.15	.68	5.97	.76	6.09	.71
	Total	6.09	.72	6.26	.66	6.08	.76	6.14	.72
Odor	Female	3.82	1.43	4.42	1.56	5.96	.88	4.75	1.59
	Male	4.39	1.02	3.69	1.34	5.38	.61	4.47	1.25
	Total	4.04	1.30	4.08	1.49	5.72	.82	4.63	1.46
Touch	Female	3.57	1.21	4.36	1.42	4.60	1.33	4.17	1.38
	Male	4.09	1.26	4.13	1.14	3.98	1.35	4.07	1.22
	Total	3.77	1.24	4.25	1.29	4.34	1.35	4.13	1.31
R/K	Female	4.80	1.04	5.34	.87	5.44	.97	5.19	1.00
	Male	5.34	.92	4.97	.92	4.84	1.09	5.03	.98
	Total	5.01	1.02	5.17	.90	5.19	1.05	5.12	.99
In words	Female	3.08	1.29	3.60	1.59	3.57	1.25	3.41	1.38
	Male	3.51	1.30	3.13	1.22	3.15	1.21	3.25	1.23
	Total	3.25	1.29	3.39	1.43	3.40	1.24	3.34	1.31
Back in time	Female	5.09	1.24	5.62	.76	5.54	.96	5.41	1.03
	Male	5.50	.92	5.35	.94	4.98	.88	5.27	.92
	Total	5.25	1.13	5.50	.85	5.31	.96	5.35	.98
Story	Female	4.79	1.06	4.92	1.08	5.09	1.29	4.93	1.14
	Male	4.79	.85	4.28	1.22	4.45	1.11	4.49	1.08
	Total	4.79	.97	4.62	1.18	4.83	1.24	4.75	1.13
Importance	Female	3.28	.93	2.99	.96	3.18	1.01	3.15	.96
	Male	3.36	1.22	3.27	.76	3.36	1.16	3.33	1.03
	Total	3.31	1.04	3.12	.87	3.25	1.06	3.23	.99
Real/Imagine	Female	6.45	.67	6.62	.56	6.59	.65	6.55	.63
	Male	6.64	.51	6.33	.62	6.51	.56	6.48	.57
	Total	6.53	.61	6.48	.59	6.56	.61	6.52	.60
Frequency	Female	2.71	.79	2.86	.88	3.05	1.03	2.87	.91
	Male	3.25	1.42	2.91	.68	2.75	.92	2.96	1.03
	Total	2.92	1.09	2.88	.78	2.93	.98	2.91	.96
Emotion then	Female	4.98	.71	4.84	1.19	5.00	.97	4.94	.96
	Male	4.82	.97	4.61	.84	4.75	.71	4.72	.83
	Total	4.92	.81	4.73	1.04	4.89	.87	4.85	.91
Emotion now	Female	3.92	1.18	4.29	1.03	4.21	1.06	4.14	1.09
	Male	3.82	.83	3.85	1.05	4.28	.83	3.99	.92
	Total	3.88	1.05	4.09	1.05	4.24	.96	4.07	1.02
Vividness	Female	3.87	1.06	4.22	.96	4.39	.95	4.16	1.00
	Male	4.06	.57	3.75	.96	3.90	1.06	3.90	.89
	Total	3.95	.90	4.01	.97	4.18	1.01	4.05	.96

Table 8 (continued)

		Verbal		Visual		Olfactory		Overall	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Valence	Female	.44	.86	.16	.97	.05	.82	.22	.88
	Male	.13	.69	-.03	.82	.18	1.02	.09	.85
	Total	.32	.80	.07	.90	.10	.90	.16	.87
Age at event	Female	14.89	3.18	15.55	4.26	13.52	3.22	14.61	3.60
	Male	14.56	3.47	13.79	2.93	14.58	2.87	14.29	3.04
	Total	14.76	3.26	14.74	3.76	13.96	3.09	14.48	3.37
Last recalled	Female	458.70	544.1	309.0	320.76	311	434.30	361.81	446.43
	Male	259.84	288.5	452.9	566.90	459.2	430.98	397.16	451.88
	Total	382.22	468.5	375.4	450.78	372.5	433.84	376.66	447.16
% 0-9 age	Female	22.26	22.29	23.95	26.78	30.13	24.17	26.73	24.24
	Male	28.00	23.29	22.57	22.26	16.72	19.88	22.21	21.83
	Total	24.46	22.55	25.47	24.62	24.57	23.21	24.83	23.28
% 10-19 age	Female	65.10	27.09	49.19	37.59	58.91	22.92	58.11	29.73
	Male	48.87	25.56	65.31	31.33	76.48	22.07	64.18	28.47
	Total	58.86	27.37	56.63	35.34	66.20	23.95	60.66	29.22
% 20-29 age	Female	12.62	23.07	22.84	33.31	10.94	20.19	15.15	25.91
	Male	23.12	24.84	12.10	21.03	6.79	15.12	13.60	21.19
	Total	16.66	24.01	17.88	28.49	9.22	18.17	14.50	23.95

Table 9. Age at Event for Each Cue Item

	Verbal		Visual		Olfactory	
	Mean	SD	Mean	SD	Mean	SD
Raki age	16.00	4.73	18.24	3.45	15.36	4.53
Mothball age	15.94	5.29	12.94	6.43	11.54	5.63
Lavender age	15.91	4.55	16.36	6.43	14.24	5.33
Coffee age	18.00	2.99	18.67	4.51	17.38	3.71
Strawberry age	14.79	5.35	14.24	7.38	14.37	5.36
Glue age	13.74	5.48	12.91	5.19	11.73	4.87
Iodine age	10.00	4.98	11.08	5.51	12.83	5.66

Table 10. Means and Standard Deviations for Repeated Measures ANOVA

Scales	Raki		Moth ball		Lavender		Coffee		Strawberry		Glue		Iodine	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Reliving	5.75	1.11	4.50	1.60	4.90	1.61	5.40	1.69	5.95	1.46	4.45	1.23	5.45	1.39
Hear	5.00	1.74	3.25	2.04	3.70	2.05	4.80	2.04	4.60	2.08	3.25	1.83	4.55	1.87
See	5.95	0.94	5.00	1.62	5.20	1.60	5.85	1.30	5.90	1.37	5.00	1.58	5.75	1.37
Talk	5.15	1.87	3.45	1.90	4.10	2.17	5.25	1.99	4.95	1.76	3.70	1.62	1.90	1.71
Emotion	5.45	1.91	4.05	1.63	4.40	1.42	5.45	1.79	6.65	1.53	4.25	1.55	1.35	1.26
Setting	6.50	0.76	6.40	0.75	5.70	1.45	6.60	0.99	5.95	1.60	5.75	1.51	6.15	1.59
Odor	5.25	1.48	5.25	1.44	5.25	1.77	5.60	1.31	5.05	2.03	4.60	1.69	4.60	2.32
Touch	4.70	1.49	4.20	1.90	4.05	1.98	5.05	1.60	5.55	1.53	4.20	1.64	5.10	1.86
Remember know	6.00	0.85	4.65	1.46	5.00	1.41	5.50	1.57	5.75	1.55	4.55	1.66	5.40	1.63
In words	3.45	1.84	2.55	1.53	3.20	2.09	3.70	2.17	3.15	1.87	3.20	1.90	3.05	1.84
Travel back Story	6.00	0.91	5.30	1.30	5.55	0.93	5.75	1.55	5.80	1.39	5.10	1.48	6.05	1.19
Importance	4.95	1.79	4.10	1.99	4.05	2.06	5.15	2.00	5.20	1.76	4.35	1.89	5.00	1.77
Real/imagine	4.40	1.42	2.85	1.53	2.95	1.53	4.15	1.87	3.25	1.65	3.25	1.58	4.20	1.73
Frequency	6.90	0.30	6.25	0.78	6.25	1.37	6.85	0.36	6.80	0.41	6.60	0.68	6.60	0.82
Age	3.85	1.53	1.85	1.69	1.85	1.08	3.50	2.01	2.70	1.75	2.20	1.19	3.35	1.66
Emotion then	17.85	4.89	12.70	6.40	17.65	5.97	19.45	4.61	16.40	7.72	13.55	5.47	11.90	6.23
Emotion now	5.60	1.23	4.05	1.50	5.85	1.42	5.15	1.75	4.85	1.38	4.60	1.23	5.70	1.34
Vividness	5.50	1.19	4.00	1.80	4.10	0.96	4.70	1.83	4.40	1.27	4.00	1.55	4.55	1.46
Valence	5.90	0.78	4.10	1.37	4.85	1.13	5.40	1.81	5.70	1.34	4.40	1.23	5.10	1.99
	1.30	1.59	0.35	1.66	0.25	1.20	0.40	1.84	0.75	1.61	0.60	1.50	-0.75	1.74

Table 11. Bonferroni Significance Levels for Repeated Measures ANOVA

		Raki	Mothball	Lavender	Coffee	Strawberry	Glue	Iodine
reliving	Raki		.009 a	.039 a			.000 a	
	Mothball				.03 b	.033 b		
	Lavender							
	Coffee						.017 a	
	Strawberry						.010 a	
	Glue							
	Iodine							
hear	Raki		.004 a	.003 a			.001 a	
	Mothball				.002 b			.004 b
	Lavender				.014 b			
	Coffee						.004 a	
	Strawberry						.045 a	
	Glue							.012 b
	Iodine							
see	Raki							
	Mothball							
	Lavender							
	Coffee							
	Strawberry							
	Glue							
	Iodine							
talk	Raki		.007 a				.032 a	
	Mothball				.002 b	.041 b		.001 a
	Lavender							
	Coffee						.03 a	
	Strawberry						.04 a	
	Glue							.09 a
	Iodine							
emotion	Raki		.024 a	.004 a			.019 a	
	Mothball				.019 b	.022 b		.024 a
	Lavender				.017 b	.004 b		.008 a
	Coffee						.038 a	
	Strawberry						.019 a	
	Glue							.024 a
	Iodine							
setting	Raki							
	Mothball							
	Lavender							
	Coffee							
	Strawberry							
	Glue							
	Iodine							

Table 11 continued

	Raki	Mothball	Lavender	Coffee	Strawberry	Glue	Iodine
odor	Raki						
	Mothball						
	Lavender						
	Coffee						
	Strawberry						
	Glue						
	Iodine						
touch	Raki						
	Mothball						
	Lavender						
	Coffee						
	Strawberry						
	Glue						
	Iodine						
Remember/know	Raki	.000 a	.008 a			.003 a	
	Mothball			.03 b	.04 b		.03 b
	Lavender						
	Coffee						
	Strawberry						
	Glue						
	Iodine						
In words	Raki	.015 a					
	Mothball			.015 b			.010 b
	Lavender						
	Coffee						
	Strawberry						
	Glue						
	Iodine						
Travel back	Raki	.02 a				.04 a	
	Mothball						.04 b
	Lavender						
	Coffee						
	Strawberry						
	Glue						
	Iodine						
Story	Raki						
	Mothball						
	Lavender						
	Coffee						
	Strawberry						
	Glue						
	Iodine						

Table 11 continued

	Raki	Mothball	Lavender	Coffee	Strawberry	Glue	Iodine
Importance	Raki	.000 a	.026 a		.011 a	.045 a	
	Mothball			.004 b			.037 b
	Lavender			.039 b			.014 b
	Coffee				.031 b		
	Strawberry						
	Glue						
	Iodine						
Real/imagine	Raki	.001 a				.034 a	
	Mothball			.005 b	.003 b		.012 b
	Lavender						
	Coffee						
	Strawberry						
	Glue						
	Iodine						
Frequency	Raki	.001 a	.001 a		.010 a	.004 a	
	Mothball			.001 b			.006 b
	Lavender			.003 b			.010 b
	Coffee				.043 a	.049 a	
	Strawberry						
	Glue						
	Iodine						
Age	Raki	.013 a				.032 a	.003 a
	Mothball		.022 b	.001 b			
	Lavender						.003 a
	Coffee					.005 a	.000 a
	Strawberry						.032 a
	Glue						
	Iodine						
Emotion then	Raki	.005 a	.003 b			.022 a	
	Mothball			.004 b			.000 b
	Lavender			.006 a			.000 a
	Coffee						
	Strawberry						
	Glue						.006 b
	Iodine						
Emotion now	Raki	.002 a	.002 a		.000 a	.007 a	
	Mothball						
	Lavender						
	Coffee						
	Strawberry						
	Glue						
	Iodine						

Table 11 continued

	Raki	Mothball	Lavender	Coffee	Strawberry	Glue	Iodine
Vividness	Raki	.000 a	.004 a			.001 a	.031 a
	Mothball		.037 b	.001 b	.003 b		.000 b
	Lavender						
	Coffee					.033 a	
	Strawberry					.014 a	
	Glue						
	Iodine						
Valence	Raki						.000 a
	Mothball						
	Lavender						
	Coffee						
	Strawberry						.026 a
	Glue						.041 a
	Iodine						

a means the mean score of the item on left is higher than the mean score of the item on top.

b means the mean score of the item on top is higher than the mean score of the item on left

For example for reliving “.009a” means raki rating is higher than mothball rating

Table 12. Numbers and Percentages of Odors Named and Memories Given for Each Condition

		Yes	No
Raki	Correct	26 (63.4 %)	0
	Incorrect	5 (12.2 %)	3 (7.3 %)
	Couldn't name	2 (4.9 %)	5 (12.2 %)
Mothball	Correct	20 (48.78 %)	6 (14.63 %)
	Incorrect	5 (12.2 %)	2 (4.9 %)
	Couldn't name	0	6 (14.63 %)
Lavender	Correct	17 (41.46 %)	4 (9.75 %)
	Incorrect	5 (12.2 %)	7 (17.07 %)
	Couldn't name	3 (7.3 %)	5 (12.2 %)
Coffee	Correct	31 (75.60 %)	6 (14.63 %)
	Incorrect	2 (4.9 %)	0
	Couldn't name	0	2 (4.9 %)
Strawberry	Correct	26 (63.41 %)	13 (31.70 %)
	Incorrect	0	0
	Couldn't name	0	1 (2.43 %)
Glue	Correct	19 (46.34 %)	4 (9.75 %)
	Incorrect	10 (24.39 %)	5 (12.2 %)
	Couldn't name	1 (2.43 %)	2 (4.9 %)
Iodine	Correct	23 (56.09 %)	1 (2.43 %)
	Incorrect	5 (12.2%)	2 (4.9 %)
	Couldn't name	1 (2.43 %)	8 (19.51 %)

Each item was presented to 41 participants. The numbers of in table indicate number of participants that fulfilled the particular condition and numbers in parenthesis indicate its proportion to 41. For example for raki, of 41 participants 63.4 % correctly named the item and gave memory while 12.2 % couldn't name the odor and didn't give memory.

Table 13. Means and Standard Deviations for MANOVA Including Only Correctly Named Odors

		Verbal		Visual		Olfactory		Overall	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Reliving	Female	4.95	1.09	5.34	.87	5.26	1.08	5.18	1.02
	Male	4.94	1.02	4.85	.97	5.03	.79	4.94	.91
	Total	4.94	1.05	5.12	.94	5.17	.96	5.08	.98
Hear	Female	3.99	1.41	4.22	1.23	4.41	1.27	4.20	1.30
	Male	4.45	.97	3.93	.95	3.98	1.26	4.10	1.07
	Total	4.17	1.27	4.09	1.10	4.23	1.27	4.16	1.21
See	Female	5.35	.93	5.71	.62	5.73	.79	5.59	.81
	Male	5.27	.84	5.01	1.14	5.37	.71	5.21	.92
	Total	5.32	.89	5.39	.95	5.58	.77	5.43	.87
Talk	Female	4.68	1.24	4.83	1.21	4.74	1.17	4.75	1.19
	Male	4.87	1.14	4.29	1.05	4.21	1.30	4.44	1.18
	Total	4.76	1.19	4.58	1.16	4.52	1.24	4.62	1.19
Emotion	Female	4.49	1.35	4.94	.93	5.03	1.26	4.82	1.21
	Male	4.60	.89	4.31	.87	4.50	.99	4.46	.91
	Total	4.53	1.18	4.65	.95	4.81	1.17	4.67	1.10
Setting	Female	6.05	.73	6.33	.65	6.26	.78	6.21	.73
	Male	6.17	.73	6.12	.72	5.85	.95	6.05	.80
	Total	6.09	.72	6.24	.68	6.09	.87	6.14	.76
Odor	Female	3.82	1.43	4.56	1.61	5.95	1.23	4.79	1.67
	Male	4.39	1.02	3.69	1.34	5.47	.74	4.50	1.29
	Total	4.04	1.30	4.16	1.54	5.75	1.07	4.67	1.52
Touch	Female	3.57	1.21	4.44	1.35	4.72	1.38	4.23	1.39
	Male	4.09	1.26	4.13	1.16	4.23	1.48	4.15	1.28
	Total	3.77	1.24	4.30	1.26	4.52	1.43	4.20	1.34
R/K	Female	4.80	1.04	5.41	.87	5.53	.93	5.24	.99
	Male	5.34	.92	4.98	.90	4.89	1.19	5.06	1.01
	Total	5.01	1.02	5.21	.90	5.27	1.08	5.16	1.00
In words	Female	3.08	1.29	3.63	1.63	3.57	1.32	3.42	1.41
	Male	3.51	1.30	3.08	1.23	3.18	1.23	3.24	1.24
	Total	3.25	1.29	3.38	1.46	3.41	1.28	3.35	1.34
Back in time	Female	5.09	1.24	5.65	.74	5.60	.99	5.44	1.04
	Male	5.50	.92	5.38	.92	4.79	1.31	5.21	1.09
	Total	5.25	1.13	5.52	.83	5.26	1.19	5.34	1.06
Story	Female	4.79	1.06	4.96	1.10	5.08	1.36	4.94	1.17
	Male	4.79	.85	4.29	1.21	4.52	1.16	4.52	1.09
	Total	4.79	.97	4.65	1.18	4.85	1.30	4.76	1.15
Importance	Female	3.23	.93	3.05	1.05	3.23	1.03	3.19	.99
	Male	3.36	1.22	3.36	.92	3.47	1.34	3.39	1.14
	Total	3.31	1.04	3.19	.99	3.33	1.16	3.28	1.06
Real/Imagine	Female	6.45	.67	6.62	.56	6.60	.62	6.56	.62
	Male	6.64	.51	6.34	.60	6.50	.61	6.49	.58
	Total	6.53	.61	6.49	.59	6.56	.61	6.53	.60
Frequency	Female	2.71	.79	2.91	.96	3.02	1.17	2.88	.98
	Male	3.25	1.42	2.90	.69	2.76	1.21	2.96	1.12
	Total	2.92	1.09	2.90	.84	2.91	1.18	2.91	1.04
Emotion then	Female	5.04	.80	4.90	1.24	4.98	.99	4.98	1.00
	Male	4.87	.97	4.70	.93	4.78	.85	4.78	.90
	Total	4.97	.86	4.81	1.10	4.90	.93	4.89	.96
Emotion now	Female	3.92	1.18	4.31	1.05	4.29	1.15	4.17	1.13
	Male	3.82	.83	3.88	1.07	4.23	.84	3.98	.93
	Total	3.88	1.05	4.11	1.07	4.26	1.03	4.09	1.05

Table 13 (continued)

		Verbal		Visual		Olfactory		Overall	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Vividness	Female	4.71	.94	5.20	.73	5.39	.98	5.10	.93
	Male	5.03	.96	4.62	.98	4.79	1.03	4.80	.99
	Total	4.83	.95	4.93	.89	5.14	1.03	4.97	.96
Valence	Female	.44	.86	.13	.94	.14	1.04	.24	.95
	Male	.13	.69	-.07	.89	.23	1.03	.09	.88
	Total	.32	.80	.04	.91	.18	1.02	.18	.92
Age at event	Female	14.89	3.18	15.72	4.33	13.55	3.62	14.68	3.76
	Male	14.56	3.47	13.67	2.92	14.14	2.89	14.44	3.08
	Total	14.76	3.26	14.77	3.84	14.21	3.39	14.57	3.58
Last recalled	Female	458.70	544.18	281.40	314.51	225.32	229.75	323.56	396.87
	Male	259.84	288.57	475.56	587.24	540.50	624.94	432.92	533.68
	Total	382.22	468.53	371.01	464.71	356.01	459.65	369.51	460.41

Table 14. Regression Analysis for Metacognitive Judgments.

	Hear	See	Talk	Emotion	Setting	Odor	Touch	In words	Story	Importance	Frequency
<b>Reliving</b>											
Verbal				.49							
Visual		.46									
Olfactory				.30			.30				
<b>Remember/know</b>											
Verbal											
Visual			.35				.26		.60		-.29
Olfactory				.44	.39						
<b>Back in time</b>											
Verbal			.34	.59							-.26
Visual				.46							
Olfactory							.48				
<b>Real/Imagine</b>											
Verbal					.50			-.33			
Visual											
Olfactory											

## 12. FIGURES

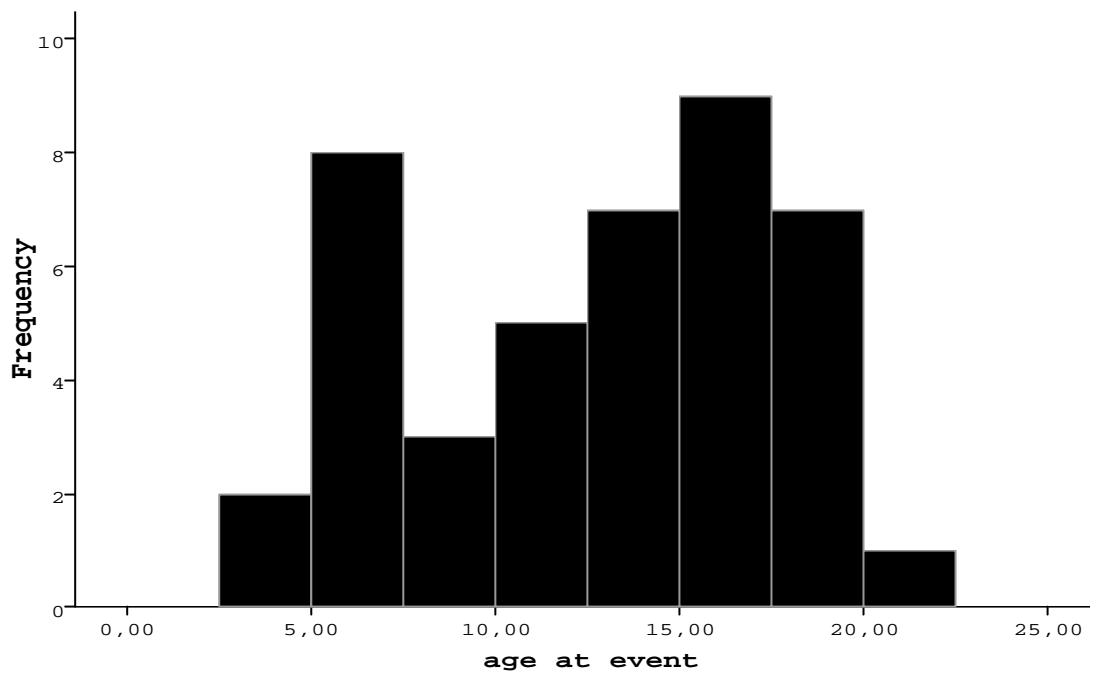


Figure 1. Distribution of age at event

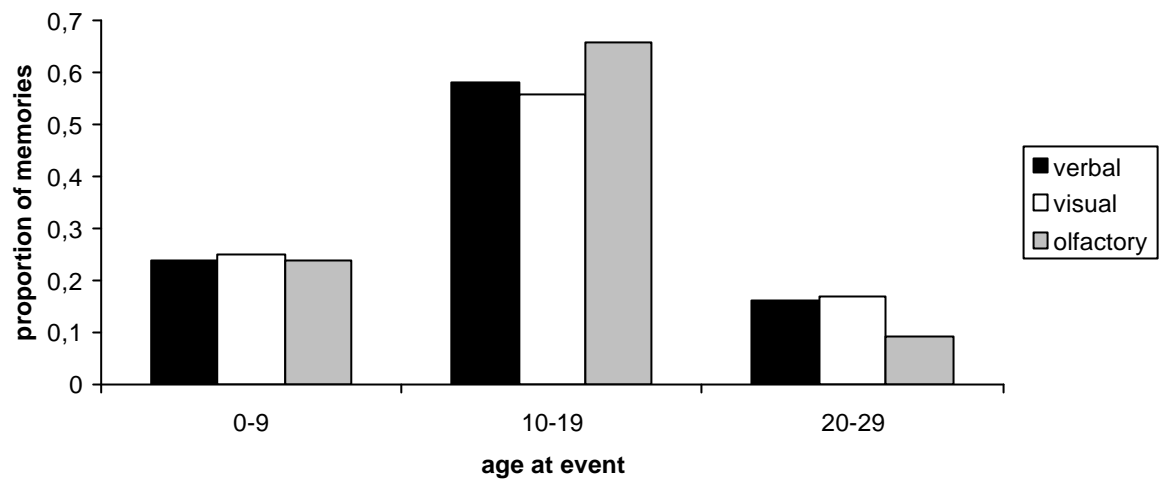


Figure 2. Age at event of memories

## APPENDICES

## APPENDIX A: Autobiographical Memory Questionnaire

### Otobiyografik Ani Anketi

Lütfen, sorulari yanıtlamaya başlamadan önce bu anı hakkında biraz düşünün ve size en uygun olan rakami işaretleyin.

1. Olayı hatırlarken, onu yeniden yaşıyormuş gibi hissediyorum.

**1**      **2**      **3**      **4**      **5**      **6**      **7**  
Hiç                      Belli belirsiz                      Net bir biçimde                      Son derece net bir biçimde

---

2. Olayı hatırlarken, olay anındaki sesleri zihnimde işitebiliyorum.

**1**      **2**      **3**      **4**      **5**      **6**      **7**  
Hiç                      Belli belirsiz                      Net bir biçimde                      Son derece net bir biçimde

---

3. Olayı hatırlarken, olay anındaki görüntüleri zihnimde görebiliyorum.

**1**      **2**      **3**      **4**      **5**      **6**      **7**  
Hiç                      Belli belirsiz                      Net bir biçimde                      Son derece net bir biçimde

---

4. Olayı hatırlarken, olay anında benim ya da başka insanların konuştuğunu hatırlıyorum.

**1**      **2**      **3**      **4**      **5**      **6**      **7**  
Hiç                      Belli belirsiz                      Net bir biçimde                      Son derece net bir biçimde

---

5. Olayı hatırlarken, olay anındaki duygularımı şimdi de hissediyorum.

**1**      **2**      **3**      **4**      **5**      **6**      **7**  
Hiç                      Belli belirsiz                      Net bir biçimde                      Son derece net bir biçimde

---

6. Olayı hatırlarken, olayın geçtiği yeri hatırlayabiliyorum.

**1**      **2**      **3**      **4**      **5**      **6**      **7**  
Hiç                      Belli belirsiz                      Net bir biçimde                      Son derece net bir biçimde

---

7. Olayı hatırlarken, olay anındaki koku ya da kokuları şimdi de hatırlıyorum.

**1**      **2**      **3**      **4**      **5**      **6**      **7**  
Hiç                      Belli belirsiz                      Net bir biçimde                      Son derece net bir biçimde

---

8. Olayı hatırlarken o an temas ettiğim şeylerin yumusaklık/sertlik ya da sıcaklık/sogukluk gibi dokunsal niteliklerini hatırlayabiliyorum.

**1**      **2**      **3**      **4**      **5**      **6**      **7**  
Hiç                      Belli belirsiz                      Net bir biçimde                      Son derece net bir biçimde

---

9. İnsanlar bazı olayların, detaylarını hatırlamasalar da başlarından geçtiğini bilirler. Ben anımı hatırlarken, bu olayın basımdan geçtiğini bilmekten öte onu gerçekten detaylarıyla hatırlayabiliyorum.

**1**      **2**      **3**      **4**      **5**      **6**      **7**  
Hiç                      Belli belirsiz                      Net bir biçimde                      Son derece net bir biçimde

---

10. Olay aklıma daha çok kelimeler halinde geliyor.  
1 2 3 4 5 6 7  
Hiç Belli belirsiz Net bir biçimde Son derece net bir biçimde

---

11. Olayı hatırlarken, olayın olduğu zamana geri döndüğümü ve olayı dışarıdan seyreden biri değil olayın içinde olan, olaya doğrudan katılan biri olduğumu hissediyorum.  
1 2 3 4 5 6 7  
Hiç Belli belirsiz Net bir biçimde Son derece net bir biçimde

---

12. Olayı hatırlarken, olay aklıma yalnızca bir durum, gözlem ya da sahne şeklinde parça parça değil; sözcükler ya da resimlerden oluşan bütün bir hikaye ya da olay olarak geliyor.  
1 2 3 4 5 6 7  
Hiç Belli belirsiz Net bir biçimde Son derece net bir biçimde

---

13. Bu olay bana bir mesaj verdiği için ya da yaşamımda kritik bir zamanı veya dönüm noktasını simgelediği için benim için önemli bir anıdır.  
1 2 3 4 5 6 7  
Çok önemsiz Önemsiz Önemli Son derece önemli

---

14. Bu olayın gerçekten hatırladığım şekilde gerçekleştiğine ve olmaması herhangi bir şeyi hayal etmediğime ya da kurmadığıma inanıyorum.  
1 2 3 4 5 6 7  
%100 hayal ürünü %100 gerçek

---

15. Olduğundan beri, bu olay hakkında düşündüm ya da konuştum.  
1 2 3 4 5 6 7  
Hiç düşünmedim Bazen Birçok kez Hayatımda hakkında en sık düşündüğüm/konuştüğüm olaylardan biri konuşmadım

---

16. Lütfen olayın tarihini (gün / ay / yıl) olabildiğince doğru bir şekilde hatırlamaya çalışın. Tahmin etmeniz gerekse bile lütfen bir gün, ay ve yıl yazın. Eğer ayı biliyor ama günü bilmiyorsanız, ayın başı, ortası veya sonu için sırasıyla 1, 15 ya da 30 yazın. Bazen olayın tarihini hatırlamak için tatiller, doğum günleri ya da okulda olduğunuz yıllar gibi bilinen tarihler kullanmak yardımcı olabilir.

---

17. Olay gerçekleştiği sırada hissettiğim duygular...  
1 2 3 4 5 6 7  
Son derece zayıftı Ne zayıf, ne güçlüydü Son derece güçlüydü

---

18. Şimdi olayı hatırlarken hissettiğim duygularım .....  
1 2 3 4 5 6 7  
Son derece zayıf Ne zayıf, ne güçlü Son derece güçlü

---

19. Bu olayı şu anda çok canlı biçimde anımsıyorum.  
1 2 3 4 5 6 7  
Hiç Belli belirsiz Net bir biçimde Son derece net bir biçimde

---

20. Bu anı sizin için ne kadar olumlu/olumsuz  
-3 -2 -1 0 1 2 3  
Son derece olumsuz Ne olumsuz, ne olumlu Son derece olumlu

---

**21.** Bu olayı en son hatırladığım zaman.... (Lütfen tarihi (gün / ay / yıl) olabildiğince doğru bir şekilde hatırlamaya çalışın. Eğer tam olarak tarihi bilmiyorsanız yaklaşık bir zaman verebilirsiniz)

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