# EMOTION AND COGNITION INTEGRATION – THE EFFECT OF ANGER ON WORKING MEMORY

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JULY

2022

# EMOTION AND COGNITION INTEGRATION – THE EFFECT OF ANGER ON WORKING MEMORY

BY

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DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR THE DEGREE OF

MA

IN

COGNITIVE SCIENCES

YEDİTEPE UNIVERSITY, JULY, 2022

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

***Emre Gözütok***

***01.07.2022***

## ABSTRACT

Emotions have always captured the attention of philosophy, psychology, and recently neuroscience. Throughout history, emotions were considered a separate entity from thinking and cognition. It was mostly related to irrationality. Descartes claimed emotions were part of the soul, based on his dualism theory. However, the period started with James-Lange changed this perspective. Together with cognitivist views, it has been understood that emotions have a significant influence on cognitive functions. This focus on the relationship between emotions and cognition led researchers to pay attention interaction concept. Neuroscience studies took this concept and strengthened it with integration theory. It has been shown in many studies that emotions have a significant effect on cognitive functions. In this study, I have given studies to show how this integration with perception, decision making, memory, attention, and working memory studies. Visual working memory and attention were mostly used to show this influence. However, findings of emotional influences on cognitive functions showed inconsistency. We wanted to see how one specific emotion, anger, affects visual working memory with the regulated version of the Recency-Probe Paradigm. We used memory sets with violent and neutral items and gave a recognition task to participants. Anger is a relatively less studied emotion compared to others due to its difficulty to measure and induce. We expected that anger-induced participants' reaction times and accuracy rates should differentiate from participants without induction. Even though there was a slight difference, we found no significant difference between the reaction times of the control and experimental group. In terms of accuracy also did not show a significant difference. However, there was a significant difference between reaction times to violent and neutral items inside the groups. We also found that results show inconsistency for the emotional effect on cognitive functions.

*Keywords: cognition, emotion, anger, working memory, integration*

## ÖZET

Duygular tarih boyunca felsefenin, psikolojinin ve sinirbilimin ilgisini çekmiştir. Fakat genellikle duygular ve biliş birbirinden ayrı unsurlar olarak kabul edilmekteydi. Duyguların mantıkla çelişkili olduğu varsayılıyordu. Descartes, dualizm teorisine göre duyguları ruhun bir parçası olduğunu iddia etmiştir. James-Lange ile başlayan yeni bir süreç bu durumun değişmesine sebep oldu. Bilişsel yaklaşımlar ile birlikte, duyguların diğer bilişsel işlevlere etkisi anlaşılmaya başlandı. Bu değişim, araştırmacıları duygu ve bilişler arasındaki ilişkiyi 'etkileşim' olarak açıklama tarafına yöneltti. Fakat daha sonra bu yaklaşımın yeterli olmadığı, etkileşimden daha karmaşık bir ilişki savunulmaya başlandı. Sinirbilim çalışmaları ile birlikte 'entegrasyon' teorisi ortaya çıktı. Sinirbilim bulguları duyguların bilişlerden ayırt edilemeyeceğini ortaya koydu, ayrıca bir çok çalışmada duyguların bilişsel işlevlere etkisi güçlü bir şekilde gösterildi. Bu çalışmada bu entegrasyonun algı, karar verme, bellek, dikkat ve işler bellek çalışmalarında nasıl gösterildiğini anlattık. Özellikle görsel işler hafıza ve dikkat bu çalışmalarda sıklıkla kullanılmaktadır. Biz ise özellikle öfke duygusunun görsel isle hafızayı 'Recency-Probe Paradigm'ın uyarlanmış versiyonu ile nasıl etkilediğine baktık. Bunun için şiddet içeren ve nötr simgelerden oluşan hafıza setleri hazırladık. Öfke duygusu uyarılmış katılımcıların tepki süreleri ve doğruluk oranlarının nötr gruptaki katılımcılardan farklı olmasını bekledik. Bu bulgularda sayısal olarak fark olmasına ragmen, gruplar arası anlamlı bir fark bulamadık. Gruplar içerisinde ise şiddet ve nötr itemlere verilen yanıtlar arasında anlamlı bir fark bulduk. Bulgularımız, duyguların bilişsel işlevlere etkisindeki tutarsızlık gösteren çalışmaları desteklemektedir.

*Anahtar kelimeler: biliş, duygu, işler bellek, öfke, entegrasyon*

To my family…

# ACKNOWLEDGMENTS

The author wishes to express her deepest gratitude to her supervisor and Assistant Prof. Dr. Sara Saban for their guidance, encouragement, and feedback throughout the research. Her contributions and patience meant a lot to me.

I wish to express my sincere gratitude to my family, who has been supporting me and showing their patience and belief all the time. Also, I would like to express my gratitude to my friends, Burak Berk Gültekin, Tuğçe Bayar, and Esra Cesur for their valuable support and recommendations in all manners. I am also grateful to my colleagues and school directors where I am working for the motivation and flexibility that they gave me.

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# 1. INTRODUCTION

## 1.1 Traditional Approach to Emotions

Emotions have considerable influence on our lives in daily activities. As William James expressed *"If we fancy some strong emotion, and then try to abstract from our consciousness of it all the feelings of its bodily symptoms, we find we have nothing left behind, no 'mind-stuff' out of which the emotion can be constituted, and that a cold and neutral state of intellectual perception is all that remains."* (Lynch, 1923). Yet, it has not been studied as other functions in psychology or cognitive sciences. Understanding the nature of emotions has always been a controversial topic among philosophers. Classical philosophers considered emotions as primitives rather than involving constituents. Since ancient times it has been seen apart from mind and cognitive processes. Emotions were simply accepted as feeling apart from sensory information processing (Scarantino & Ronald, 2018). Plato had a famous idea of dualism and many of the perspectives were mostly based on his dualism approach. According to this theory, emotions are part of our souls and irrelevant to bodily changes. There are emotional reactions from animals as well, however, they are not aware of these states due to a lack of soul. Aristotle was grounding on his ideas for emotions to more mind and sense combination. So, he was one of the leading names who considered the importance of mental processes on emotions (Shields & Zawadzki, 2012). The Stoics denied these assumptions and defend that emotions were forms of impulsive reactions which was sort of a threat to rational thinking (Peters, 2000).

The 19$^{th}$ century has been a milestone for psychology and the way of looking toward emotions. Here the term *emotional consciousness* has been coined which refers to being conscious of physiological responses; thereafter, William-Lange showed that emotions can be studied scientifically, because they claim that emotions were reflecting bodily responses,

therefore, they can be addressed with physiology (Shields & Zawadzki, 2012). They were focusing on the emotions that have been experienced and the awareness of these experiences. The difficulty of distinguishing emotions from one another and with other processes brought a new lack of new theories to support their claims, and this led behaviorism to take over the field. Behaviorism reduced psychology to observable behaviors, similar to the non-human animals, and after that William James proposed that this supernatural approach toward emotions does not encompass what the feeling is (Peters, 2000).

Along with behaviorism's effect on psychology, perspectives towards emotions were emphasizing that emotions should be directly examined. Even though scientists were not denying the phenomenal experience of emotion, it was widely accepted that emotions were not directly measurable, , therefore, this is not a topic for psychology. (Shields & Zawadzki, 2012). Besides its restricted studies about emotions, behaviorism had some contributions as well, such as conditioning studies.

The 60s brought a new movement, cognitivism, which emphasizes the cognitive processing of mental representation as opposed to behaviorism dominance of observable response theories. According to Arnold (1960), emotions occur in different ways in different people even though the stimulus is the same. In fact, it may also change for the same person in time. This shows that the stimulus is not solitarily bringing out emotions, therefore the appraisal/representation matters. According to Arnold (1960) and (Lazarus, 1982), object-directedness and appraisal are the main factors of emotional processing. Emotions such as happiness, sadness, or anger are related to something which is about the intentionality of the object. Therefore, one needs cognitive processes for the appraisal of the belief that has been directed to the object. There are alternative thoughts on the intentionality of feelings. One of them is representationalism which considers it related to intentional properties. One part of representationalism viewers considers emotional phenomenology as somatic bodily events.

According to others, emotional phenomenology is constituted by somatic, cognitive, conative, and affective components (Peters, 2000). Sousa provides a wider perspective on emotions by including perceptual and non-perceptual components. Again, (Gordon & de Sousa, 1991) has proposed that emotions can be explained by 'paradigm scenarios' that are shaped during childhood but within the exposure to education, art, and culture, these scenarios can be able to change. Then we see life events through these paradigm scenarios functioning as schemes. Here again, we see that reappraisal of emotions is possible in a rational way even though previous representations were evoked in childhood. These claims constituted a base for cognitive-emotional studies.

During this period, so often called the cognitive revolution, studies for the human mind differed from previous studies and changed the direction of information processing that has inspired by the improvements in computer sciences. Considering computers as a model for the mind, it has been discussed that we are processing the external stimuli as a sensory input with our cognitive systems. This era has changed and speeded up the studies of emotions radically. Emotions do not have a general understanding and view as cognition has. It can be seen from the historical background that emotion and cognition were accepted as two separate processes. Another traditional view was pointing out that cognition was related to rationality, however, emotions were related to irrationality (Lazarus, 1982). Nonetheless, after the cognitivism, these assumptions started to give their place to a more reciprocal and relevant relationship between cognition and emotions.

Whereas attention, memory, problem-solving, language, and perception have been seen as the main elements of cognition, emotions were considered a topic for social, developmental, and clinical psychology for a long time. By saying cognitive processes, it is referred to how humans first perceive the external or internal information, then storing with modification, and interpret it (D. et al., 1979). These developments caused a change in

emotion studies and directed them to investigate under components of cognitive processes (Lazarus, 1982).

### 1.2 Emotion and Cognition Integration

When emotions have been begun to examine under cognitive studies, it is understood that the relation between emotion and cognition is reciprocal. Division in emotion and cognition has been common sense in the area, however recent studies showed that these systems have interactions even though they are separate systems (Jung et al., 2014). Emotions were accepted as cold processes for other cognitive functions; however, this view has been changed through the years to the interaction concept. We know that emotion affects one's preference for which information to process. This is related to the evolutionary process of preparing us for surviving conditions by deciding what is important for us (van der Heijden, 1992). This function of filtering information with selective influences on cognitive control shows that emotions and cognition are more than interacting. However, saying that emotion and cognition have interaction is not sufficient to cover the bidirectional and complex relationship between them.

Terms of affects or interactions do not truly encapsulate the relation between emotion and cognition nor consciousness of emotion, instead, it can be explained with the integration term more coherently. Neuroscience studies have a significant contribution to the relation between emotion and cognition, within the data provided, perspectives towards emotions were changed from primary processes to a complex system (Phelps, 2006). Along with the neuroimaging studies, the concept of integration of emotion and cognition started to become the main perspective. (Ochsner & Phelps, 2007). In his prior article Gray (2004) makes an analogy to a baseball team to explain the integration term. He claims that integration can be explained by the relationship between the team members. A team is more than all the players

on the field. Although we think of each player as a separate part, it does not give us a holistic perspective of the team. So, cognition and emotion are also in the same team and even though it can be said that they are separate entities, it is not possible to claim that they are completely separable (Gray, 2004). The circuit for executive control shows how cognitive and affective functions are related and inseparable (Figure 1).

It is important to show how emotion and other cognitive functions influence each other. The period that cognitive psychology studies strengthened cognition-emotion integration has been widely supported by cognitive neuroscience data. Neuroscience studies had a boost effect on this field. Damasio's neuroscientific studies led many researchers to discuss emotions based on the somatosensory system together with brain areas (Damasio, 1998). Examining the underlying neural connections of cognitive functions and emotion relations provided a basis for brain and mind connection with cognitive representation (Phelps, 2006).

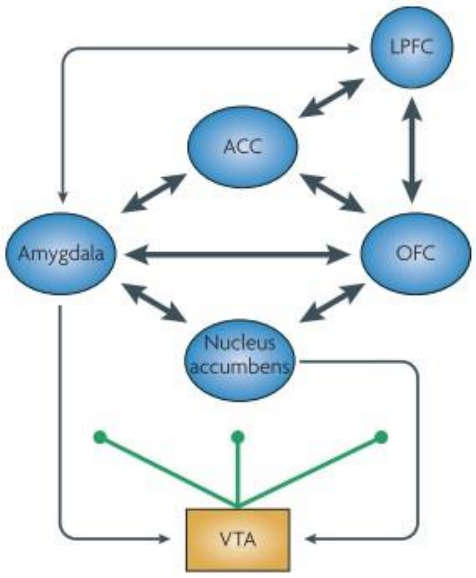


*Figure 1:* Circuit for executive control (Pessoa, 2008)

### 1.2.1. Emotion, Reasoning, and Decision Making

It has been mentioned that emotions were seen as the opposite side of the reason rationality. However, it has been understood that emotions can bias reasoning processes (Dolan, 2002). Early studies were not considering emotion's effect on decision-making processes as well (Damasio et al., 1996). Parallel to other fields, the influence of emotions has been started to take interest in cognitive sciences. Oaksford et al. (1996) found out that emotionally induced subjects showed poor performance in reasoning. One study by Channon & Baker (1994) gave subjects syllogistic reasoning tasks and results indicate that depressed subjects performed worse than non-depressed subjects. There is also another side to the influence of emotion on decision-making. Chang & Wilson (2004) showed that anger-induced subjects showed better performance on reasoning tasks in similar content. In the neuroscience field, Bechara et al. (2000) showed that decision-making processes are related to the ventromedial prefrontal cortex and supported this with a study indicating that subjects with lesions in this area of the brain showed poor performance on risky choices (Bechara, Tranel, et al., 2000).

### 1.2.2. Emotion and Perception

Emotions consistently influence our perceptual processes. It has been shown in many studies that affective stimuli can augment awareness even in pre-attentive processes (Hansen & Hansen, 1988). One of the studies related to that showed examining how mood affects the perception of the steepness of hills. Results indicate that depending on which mood induction has been applied, reporting the range of steepness has changed. Participants who were exposed to sad music stated a higher steep range than the participants who were exposed to happy music (Riener et al., 2011). This shows that visual perception of external information

can be affected by non-visual components such as emotions (Zadra & Clore, 2011). Emotion affects attentive processes strongly, however, studies show that it can also affect pre-attentive processes of perception. Phelps et al. (2006) supported this with two experiments. They showed that emotion augments perceptual processes, in this case by increasing the discrimination level. In the second experiment, they eliminated the attentive processes and found similar results indicating that emotions influence the way humans see (Phelps et al., 2006). Depending on the relevance of the task, perception performance can be impaired or improved (Dodd et al., 2016).

Although lack of awareness of emotional knowledge, these automatic responses to affective stimuli occurs stem from amygdala activity (Zadra & Clore, 2011). The connectivity between the amygdala and early visual perceptual encoding has been shown anatomically, ventral visual pathways and amygdala have reciprocal signal processing for visual inputs. (Morris et al., 1998) An fMRI study by Padmala & Pessoa (2008) shows that affective stimuli increased the functional coupling of the amygdala and visual cortex.

The effect of emotions on perception can be seen in motivational studies as well. Veltkamp et al. (2008) showed that we tend to perceive the height of a glass of water as bigger in the condition of being thirsty. For the researchers who are interested in emotion and perception relation, I suggest reading (Zadra & Clore, 2011).

### 1.2.3. Emotion and Attention

Attention can be explained as a function that decides which information will be chosen for perceptual processing (Phelps et al., 2006). Selecting the crucial stimuli in the environment with attention is highly influenced by emotions. Emotions have been working with the executive functions and enhance or impair relevant stimuli depending on the valence or arousal of the affective stimuli. There is a considerable number of studies on the

connection between emotion and visual attention. Some of these studies have shown that negative and high-arousal emotions enhanced the visual attention to threatening information, however, positive high-arousal emotions enhanced visual attention to rewarding information (Robinson, 2007). In another study, Anderson (2005) has focused on how emotions were affecting attentional processes with the attentional blink paradigm which illustrates the limited capacity for sources. However, results demonstrate that when the second target is affective, participants performed better in detection, which indicates how emotions influence attention. Equivalent results were shown in another study, the effect of inattentional blindness has been decreased for emotional stimuli. However, the results were not the same with the people who have amygdala lesions. These patients did not show improved performance for second targets (Anderson & Phelps, 2001). This shows that the amygdala has a significant role in visual attention to decide which information will be perceived depending on the affective valence. One of the main roles of the amygdala is to provide modulation for sensory processing (Figure 2). Similar to previous findings, Dolan (2002) showed that whereas a lesion in right inferior parietal cortex triggered contralesionally deficiency, this effect has been decreased when people were shown affective stimuli. Especially, the amygdala has parallel ways with the visual cortex in terms of attention processes. It has been well studied that emotional stimulus is highly related to the amygdala together with increasing relation with attention (Pessoa, 2008).

Ohman et al. (2001) showed that negative and threatening stimuli, in this case, they showed snakes and spiders, capture our attention efficiently more than neutral stimuli. Also, Öhman et al. (2010) it has been demonstrated that angry faces catch attention faster and more accurately than friendly faces among affective or neutral distractions. Schupp et al. (2003) have shown with an EEG study that EPN amplitudes increased for the emotional cues. This means that selective processing occurs during even non-emotional attention tasks. Numerous

studies have demonstrated that, attention, especially visual attention has been influenced by affective information. Schupp et al. (2003b) strengthened these results with another EEG study and ERP signals showed that the brain tends to distinguish affective stimuli. Selective attention provides sensory processing of affective information. So far, mostly early selective processes for external information have been emphasized with amygdala reflections, however, similar results can be found in prefrontal regions for executive control functions as well (Vuilleumier, 2005).

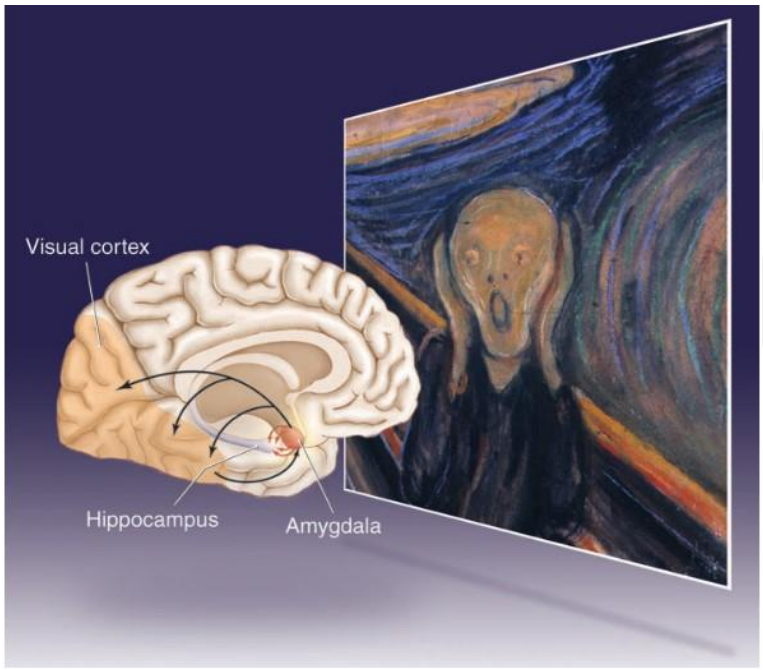


*Figure 2:* An emotional-perceptual-memory circuit in the human brain (Dolan, 2002).

### 1.2.4. Emotion, Memory, and Learning

The influence of emotions on cognition can be seen in memory and learning studies as well. Our emotional moods have a noteworthy influence on our learning processes. Depending on our mood, our cognitive functions for learning can change. We know that, even in our daily lives, we tend to remember emotional-laden memories much stronger than neutral memories, again, the amygdala has an important role in this (Levine & Pizarro, 2004). Once a stimulus has attracted attention, then, emotional information is more likely than neutral

information to hold attention and be rehearsed in working memory, increasing the likelihood that it will be stored in long-term memory (Levine & Edelstein, 2009). A study by Cahill et al. (1996) shows that participants performed better memory performance for emotional scenes than for neutral ones, in three weeks of the time range. Bradley et al. (1992) showed that emotion-laden pictures were better remembered in a long time range, they showed participants pictures from IAPS (International Affective System) and one year later they performed better memory performance in emotional pictures. Evidence & Kensinger (2007) found that negative emotions have enhancing effect on memory accuracies.

Classical conditioning studies provided convincing evidence for integration theories. Animal studies have shown that the amygdala has a significant role in fear conditioning (Mcgaugh, 2002). But it is not the only part that shows the amygdala's role, it is also important for reward and appetitive learning (Dolan, 2002). Hamann et al. (1997) found that people who have episodic memory deficits, and amnesiacs, showed enhanced memory performance for affective information. Beside encoding the information, the amygdala is also related to the retrieval of emotional information (Maratos et al., 2001). As in the fear conditioning studies, observational fear shows similar cognitive-emotional learning, supported by the activity in the amygdala (Olsson & Phelps, 2004). The network between the amygdala and hippocampus with other brain areas is important for memory consolidation. Hence, the amygdala or limbic system is not solely responsible for emotional information processing (Mcgaugh, 2002).

### 1.2.5. Emotion and Working Memory

Working memory has a restricted capacity for using and directing the information for a brief time and other executive functions (Baddeley & Hitch, 1947). Emotion and working memory relations who well-based evidence for emotion involvement in cognitive processes.

The effect of emotions has been widely studied using stimuli with pictures, words, stories, etc. (Dolan, 2002). Having additional processing or emotional stimuli may facilitate or impair working memory performance (Kensinger & Corkin, 2003). Baddeley suggests that there is no single central executive concept; instead, there are many functions of a central executive system that direct attention to relevant detail and inhibit irrelevant information. Hence, he claims that selective attention processes have a significant role in working memory operation by deciding which information to be used from long-term memory (Baddeley et al., 1998). It is well known that affective stimuli can influence the allocation of attentional sources and prioritize the relevant information (Kensinger & Corkin, 2003).

Working memory has a critical position for cognition and provides a solid base for integration theory. Visual selective attention and visual working memory have a strong relation to encoding and maintenance functions. To hold an object in working memory influences attentional direction for that object, showing that working memory also affects attention will be allocated. Hence, there is also a reciprocal connection between working memory and selective attention (Downing, 2014). Visual working memory uses the perceptual data that has been attended to and decide which relevant information to be sustained (Chun, 2011). Working memory can prioritize the emotional information processing via attention biasing. Hence, working memory performance can be increased for the emotional content (Kensinger & Corkin, 2003).

This integration can also be seen in the emotional working memory training studies. Cognitive control in emotions is reachable via training programs. Affective cognitive control is also related to the frontoparietal, especially dorsolateral prefrontal cortex which are also related to working memory (Schweizer et al., 2013). They also showed that emotional working memory training with affective stimuli has an enhancing effect on clinical groups with decreased affective cognitive control.

Examining the integration concept for emotion and working memory was provided by neuroscience studies. The left prefrontal cortex is commonly accepted as responsible for cognitive tasks; hence, this area is a good base for testing this concept (Pessoa, 2008). Jonides et al. (1992) have used N-back tests for showing that working memory and cognitive functions are related to the dorsolateral prefrontal cortex. Goldstein et al. (2007) used response inhabitation for the affective stimuli processing and found that the dorsolateral prefrontal cortex was engaged for the negative words despite this area is not related to emotionally valent stimuli processing. Another study by Perlstein et al. (2001) supported this integration concept with a working memory study; they asked participants to keep the pictures in their mind and DLPFC showed activity depending on the valence of the pictures. One crucial point of this study is that DLPFC was not shown activity during the condition which was not requiring the memory test. It shows that activity was related to emotional content (Perlstein et al., 2001). As in my experiment, Gray et al. (2002) used the emotion induction technique and gave participants difficult working memory tasks and the results of this study showed that bilateral LPFC activity was seen in emotional and working memory tasks. This outcome of LPFC demonstrates the effect of emotion on higher cognitive areas for integration. Grey et.al. (2002) claims that emotion has an impact on adjustment of the thought and behavior, and this situation also occurs oppositely. This was supported by Ochsner et al. (2002) with an fMRI study that shows how our emotions were regulated cognitively. Barbas (2000) suggests that these regulations are occurring between amygdala and PFC reciprocally, but the results are instance specific.

Kensinger and Corkin (2003) found that the effect of emotions on working memory tasks was not consistent in terms of accuracy; however, there was a slower reaction time for negatively valenced stimuli. Another research by Becerril & Barch (2011) showed that even

though there was higher accuracy, still reactions were slower for negative stimuli. Perlstein et al. (2002) showed that affective stimuli can impede working memory performance.

#### *1.2.5.1.Working Memory Capacity*

Baddeley (2012) defines visual working memory as keeping and manipulating visual sensory information. Working memory experiments mostly used colorful squares, lines in which subjects do not have any background, and assumptions for the working memory capacity were based on these studies. This capacity was commonly accepted as fixed. With three or four items for capturing. However, Brady et al. (2016) demonstrated with the interference study measuring neural activity that visual working memory capacity has more capacity than previously shown. This study explains the way for testing visual working memory by examining it with real-life objects. Brady et al. (2016) showed that in the real-life object condition, visual working memory capacity has increased.

### 1.2.6. Anger and Cognition

Anger is one of the common emotions that we share with other mammalians. The stimulated emotional state of anger is a neurochemical and neurophysiological outcome of a mental storm that convinces us to decide whether the resource of this disturbance should be punished or not (Jaak P, 2004). It is also defined as an emotional reaction to obstacles to our goals (Plutchik, 1980). Effects of anger can be seen in our daily lives so often, Mesken et al. (2007) showed that angry drivers tend to drive faster and exceed the speed limit than drivers who were not angry. Besides, Easterbrook (1959) suggested that negative emotions can cause tunnel vision by reducing peripheral vision. Zhang et al. (2016) supported these results with another study and showed that anger-induced drivers tend to have more risky decisions and scan narrower areas.

Eckhardt & Cohen (1997) showed by using the Emotional Stroop task anger-induced participants performed worse for anger words. Hansen & Hansen (1988) showed that participants showed better performance for detecting angry faces in the happy faces crowd. Recent studies show that rage systems have strong interactions with memory systems (Jaak P, 2004). A study about how trait anger was influencing cognitive processing of emotional stimuli showed that trait anger enhances the performance of emotional words, specifically words about anger (Parrott et al., 2005).

Emotion and attention studies mainly focused on negative and high-arousal emotions for threatening information (Ford et al., 2010). Emotions were examined in two dimensions, based on their valence, negative vs. positive, and engagement, low vs. high (Mogg & Bradley, 1998). For the valence dimension, high arousal biases visual selective attention for information processing for relatively valent emotions; for example, anxiety is negative but high arousal emotion, therefore it is expected to bias attention toward threatening stimuli, whereas excitement is expected to bias attention toward rewarding stimuli (Ford et al., 2010). Anger also has a negative valence, so it is expected to bias attention toward threats; however, it also shows an active approach system and according to this, it is expected to bias attention toward rewards (Carver & Harmon-Jones, 2009). Ford et al. (2010) showed that anger is directing attention to rewards, rather than threats and suggests that emotions can influence cognitive performance in a motivation-based context. Therefore, it is also important to examine how anger affects our cognitive processes. Cohen et al. (1998) found that high-trait anger subjects tend to perform better anger-related tasks when they were induced with anger. This demonstrates that anger-induced subjects automatically use their attentional sources for violent cues (Cohen et al., 1998b).

## 1.3 A Higher-Order Theory of Emotional Consciousness

Emotional studies are contributing to the way of understanding consciousness. The subjectiveness of emotions is related to conscious experiences as other perceptual ones (Ledoux & Brown, 2017).

### 1.3.1. First-Order and Higher-Order Theories of Consciousness

The main difference between these two theories is the representation levels that occur only depending on sensory inputs (first-order) or involved cognitive functions with low-level information (higher-order) (Figure 3).

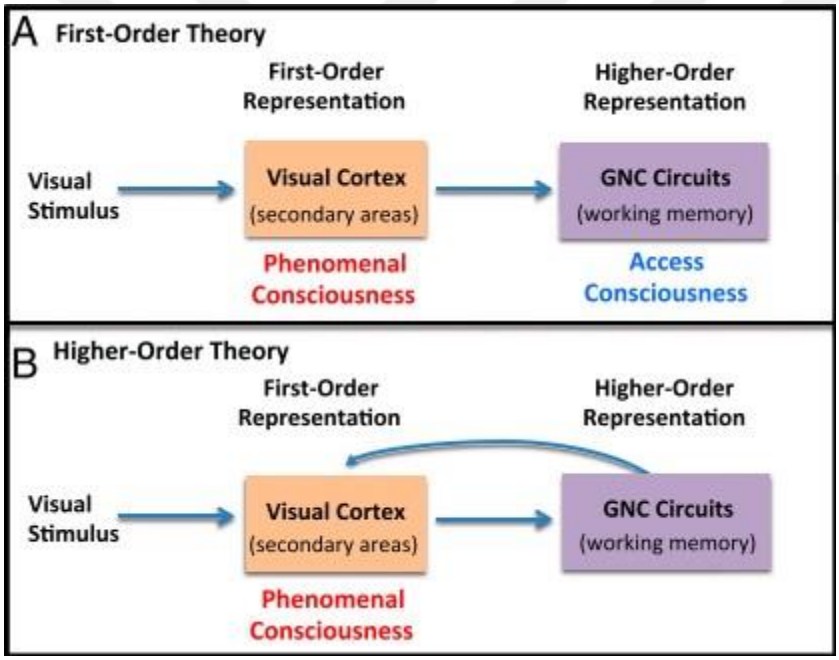


*Figure 3:* First-order and higher-order theories of consciousness (Ledoux & Brown, 2017).

Recent studies for higher-order theories (HOT) showed that awareness of the sensory information is necessary and HOT makes this awareness possible, this result indicates that first-order representation is not sufficient to create a conscious experience (Lau & Rosenthal, 2011). The general network of cognition joins this process which is related to cortical circuits

consciousness (Ledoux & Brown, 2017). However, before discussing emotional consciousness, Brown, (2012) pointed out that higher-order representation (HOR) also occurs without sensory information. Besides that, one should be aware of these conscious states. Here they suggest another concept of HOROR, a HOR of a representation which indicates that we are having a phenomenal consciousness consisting of HOR or lower information, either sensory or higher-order representation (Brown, 2015). Episodic memory shows self-knowledge about the self and one must have noetic and autonoetic experiences based on that, and here Klein (2013) suggests "self-HOROR" to explain phenomenal experiences. Because without the self, there is no emotion as Ledoux & Brown (2017) suggested, emotions are based on the self. When it comes to the higher-order theory of emotional consciousness (HOTEC), the self must be included according to higher-order theories; however, HOTEC is beyond HOT and HOROR and the main issue is whether GNC inputs are emotional or nonemotoional (Figure 4) (Ledoux & Brown, 2017).

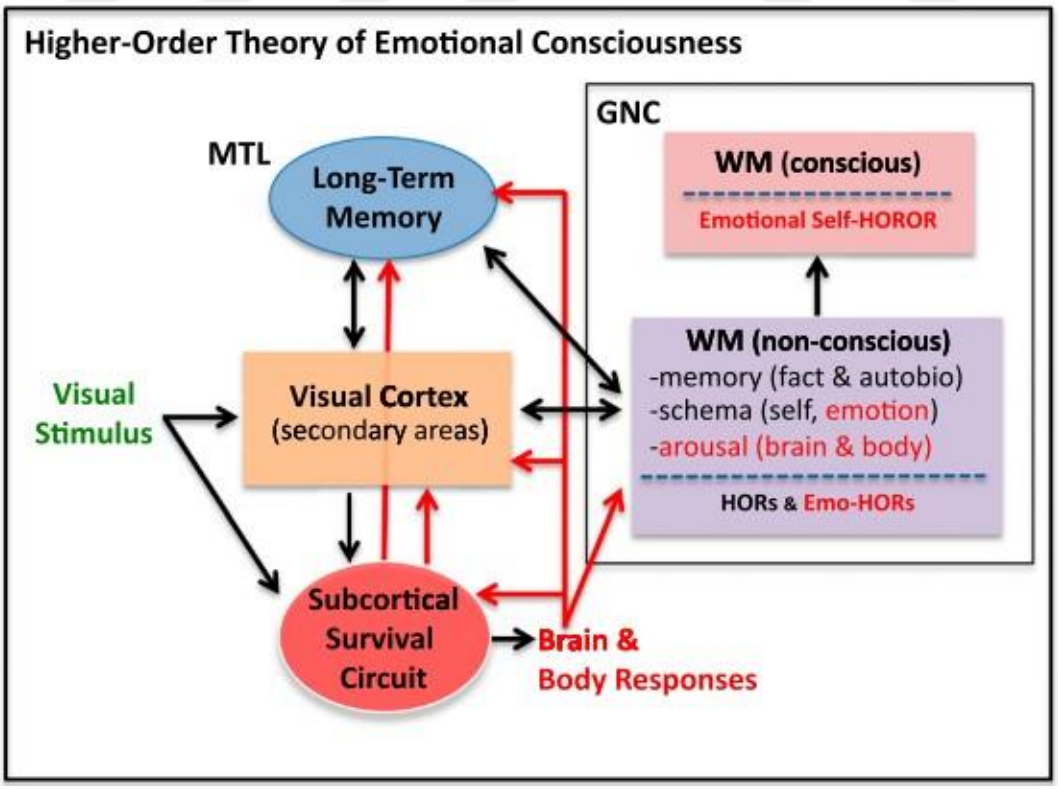

*Figure 4:* Higher-Order Theory of Emotional Consciousness (Ledoux & Brown, 2017)

### 1.4 Aim of This Study

My interest in the emotion of anger stems from my experience when I was working as a school psychological counselor. I have mostly faced anger problems, and I realized that among emotions, anger was studied less than others. Besides, anger is a challenging issue to study experimentally. The influence of emotions differentiates depending on the emotions and examination of these influences. Based on previous research on the integration of emotion and cognition, we wanted to show how emotions affect cognitive functions via challenging visual working memory tasks. This way, wanted to give supportive data for integration theory and see how this relationship between emotions and cognitive functions integrate. The majority of the studies in this field were using Emotional-Stroop Task, face recognition, or emotional story recall techniques for either emotion induction or emotional stimuli perception in experiments. We wanted participants to have an emotional state of anger with awareness to form a higher-order representation of emotional consciousness. Among many emotion induction techniques, using visual methods, such as exposure to violent content, are effective for anger-inducing (Lench et al., 2011). This is also supported by physiological data with cardiovascular measurements (Siedlecka & Denson, 2019).

As mentioned in the previous sections, we wanted to show how negative mood will affect the visual working memory performance in terms of reaction times and accuracy. Understanding which parts of the working memory performance will be affected by emotions has a critical role for emotional working memory training as well. Therefore, I believe that emotion induction with emotional working memory tasks is necessary for measuring this effect.

For this reason, we decided to use violent content for anger-inducing and expect emotionally induced participants to show slower response times for violent items in the memory set. Secondly, we expect anger-induced participants to show higher accuracy for violent items in the working memory task.

# 2. METHOD

## 2.1. Participants

108 participants from Yeditepe University Psychology Department participated in this study. Only one participant did not finish the experiment. Out of 107 participants (*M=21.45, S.D.=2.24*), 47 of them were in the experimental group, whereas 60 of them were in the control group. None of the participants reported any psychological or physical disorders. Students were rewarded with course credit due to attendance. Before the experiment, the informed consent form was given to each participant. This study was approved by Yeditepe University Humanities and Social Research Ethics Committee.

## 2.2. Procedure

The experiment was held in an isolated psychology laboratory of Yeditepe University. We designed a cognitive task on PsychoPy, a psychology experiment program, to measure working memory with and without emotional load. Before the experiment, participants filled out the 'Violence Tendency Scale' online. After this, a video, either anger-inducing or neutral, was shown to participants and then they were asked to do a revised version of the 'Recent Probes' working memory task. We used a Lenovo laptop which has a **360x240 mm** screen and its' distance from the participants was **600 mm**. To do the task, participants used a keyboard, and their responses were recorded.

## 2.3. Experimental Design

We formed two groups: an anger group and a neutral group. To avoid distraction from others, we took participants individually. The participants were assigned to either group randomly. In both conditions, the experiment starts with the practice session, and participants had feedback on this part. During the practice session memory sets and recognition items were shown eight times. Each memory set was including eight items, 4 of them were violent

and 4 of them were neutral. After the practice session, anger-inducing videos with child battering content were shown to the anger group, and participants were asked to do a working memory task which is similar, but the longer version shown in the practice session. During the main working memory task, memory sets were shown to the participants 18 times and again each item were including eight items. We wanted the be sure that the participants were in a state of emotionally angry after the anger-inducing video, therefore, we added an emotion scale based on Paul Ekman's universal emotions: anger, enjoyment, sadness, fear, disgust, and surprise. In this part, we asked participants to mark the options from 1 to 5 for each emotion according to their emotional intensity. Due to complexity and lack of scales which are measuring universal emotions, we prepared our own scale to measure them. Self-report-based scales are consistent for deciding the valence of emotional states; therefore, we prepared a self-report-based emotion scales in PsychoPy program (Hadinejad et al., 2019) Anger and the neutral group had the same procedure, however, the only difference between the two procedures was the video that was shown in the experiment.

### 2.3.1. Anger Condition

For the anger group, the experiment starts with the introduction part. Here, the experiment process is explained detailed. After that, there was a practice session. In this session, participants were shown item groups (memory set) with eight items, four violence-related items, and four neutral items, for 2 seconds and they were told to focus and memorize those items. Then a blank page for 2 seconds and then they were shown items one by one either from the memory set or not. Subjects were told to respond as fast as possible to have proper response time data. If the item was from the memory set, subjects had to press 'y' and in the other case, subjects had to press 'n.' This one set has repeated eight times and according to the validity of the subjects' responses, we gave them feedback. In the correct answer '*Congrats, you gave the right answer!'* and in the wrong answer *'Sorry, you gave the*

*wrong answer!'* feedback was given. Following this, another instruction was given to clarify that the practice session was over, and they will be shown a video, and after that, participants were told that they will have a similar task after the video and will not have feedback anymore. At the end of the real task, there will be an emotion scale based on universal emotions to see if that anger-inducing video worked or not. The videos for the anger group include scenes about violence against children.

### 2.3.2. Neutral Condition

For the neutral group, the experiment starts with the introduction part. Here, the experiment process is explained detailed. After that, there was a practice session. In this session, participants were shown item groups (memory set) with eight items, four violence-related items, and four neutral items, for 2 seconds and they were told to focus and memorize those items. Then a blank page for 2 seconds and then they were shown items one by one either from the memory set or not. Subjects were told to respond as fast as possible to have proper response time data. If the item was from the memory set, subjects had to press 'y' and in the other case, subjects had to press 'n.' This one set has repeated eight times and according to the validity of subjects' responses, feedback was given. In the correct answer '*Congrats, you gave the right answer!'* and in the wrong answer *'Sorry, you gave the wrong answer!'* feedback was given. Following this, another instruction was given to clarify that the practice session was over, and they will be shown a video, and after that, participants were told that they will have a similar task after the video and will not have feedback anymore. At the end of the real task, there will be an emotion scale based on universal emotions. The videos for the neutral group include scenes from the 'Kramer vs Kramer' movie. The scenes were related to parents with children having an enjoyable time.

### 2.3.3. Stimuli

Before choosing the items, we prepared a survey for undergraduate and graduate students which they could rate each item from one to five according to their relevance to violence. The question was ‘Please rate the following icons from 1 to 5 according to their relevance to violence’. We categorized items as violent those with a score greater than three and as neutral those with a score less than three. For the anger group videos, we used content from TV news including violence by adults towards children. And for the neutral group videos, we used clips from the ‘Kramer vs Kramer’ movie and we tried to use scenes with adults and children doing daily routines for eliminating priming and providing a proper comparison. This video was considered as neutral, we carefully chose the scenes that might not release happy mood. The video was including a father spending time with his son in a normal routine without having a warm and happy scene.

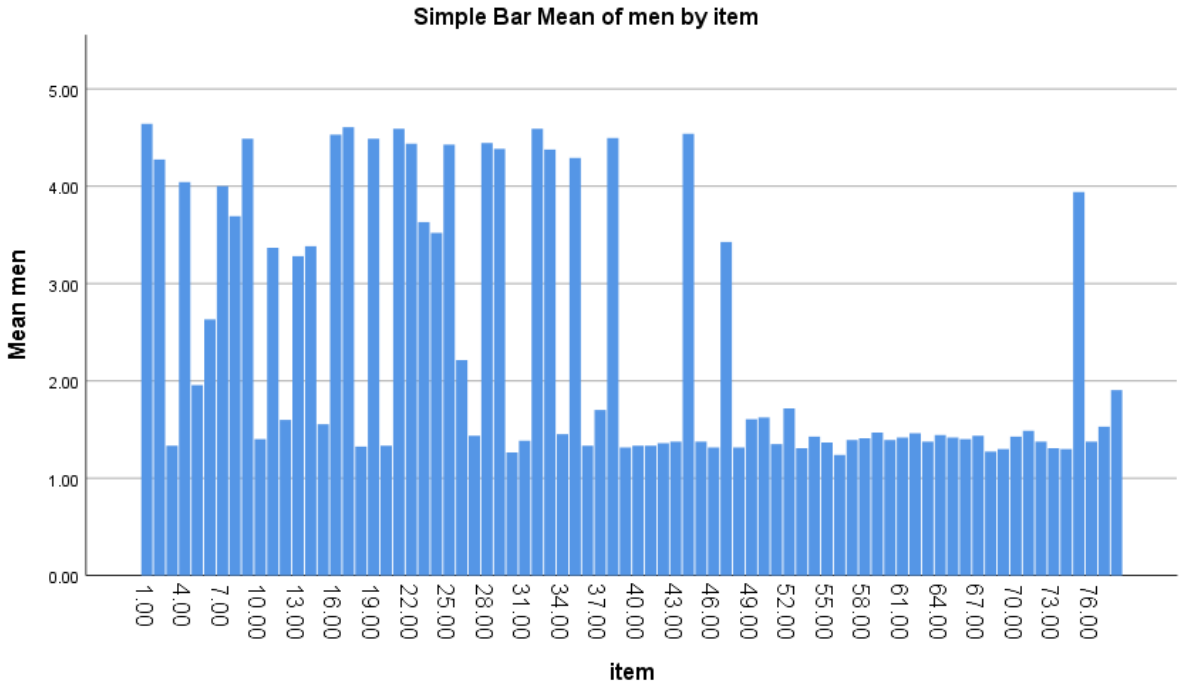


*Figure 5:* Items

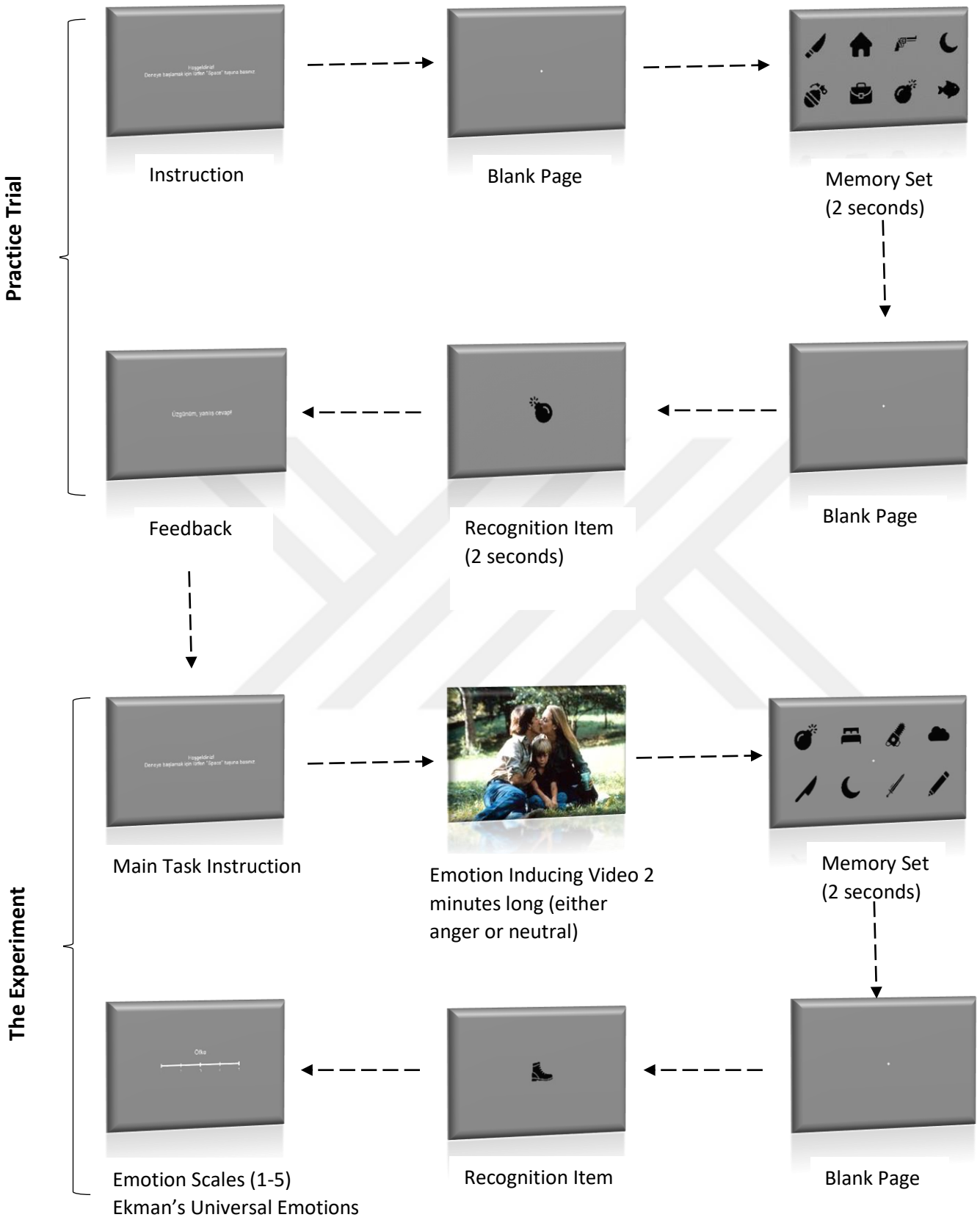


*Figure 6:* The Experimental Setup

# 3. RESULTS

Statistical analysis has been made with the SPSS software 28th version. We used a .05 significance level in all procedures. To exclude outliers in the data Z scores have been identified. The data with higher of lower Z scores than 2 and -2 have been excluded. Besides, the answers to first two questions have been excluded due to primacy effect. Out of 818 data, 38 were excluded. To check the normality, we used Shapiro Wilk and Kolmogorov-Smirnov Normality Test, Kurtosis – Skewness values, and graphical analysis. Reaction times were reported in milliseconds.

## 3.1. Violence Tendency and Emotion Scales

### 3.1.1. Violence Tendency Scale

Before analyzing the experimental data, to eliminate the tendency to violence parameter Independent Sample t-test between groups has been applied. There was no significant difference ($p<0.05$) between the experimental group ($M=1.97, SD=0.46$) and control group ($M=1.91, SD=0.37$). This means that experimental results are not affected by the participants' tendency toward violence.

**Table 1**.

*Independent Samples T Test*

| **Variable** | **Groups** | *N* | *M* | *S.D.* | *p* |
|---|---|---|---|---|---|
| **Violence Tendency Scale** | Experimental | 48 | 1.97 | .46 | .408 |
| | Control | 59 | 1.91 | .37 | |

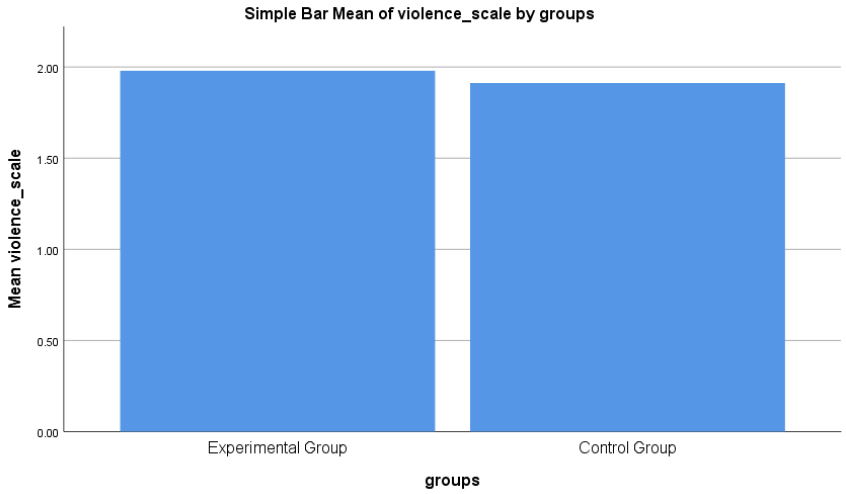


*Figure 7:* Violence Tendency Scale

### 3.1.2. Emotion Scales

After the manipulation video, participants had to rate their emotions based on Paul Ekman's universal emotions (Ekman, P. 1999). For all emotion scales, the Independent Samples t-test has been applied in all cases.

#### *3.3.1.1. Anger*

There was a significant difference *($p<0.05$)* between the anger scale rates of the experimental group *($M=4.35, SD=.98$)* and the control group *($M=1.6, SD=.80$).* According to Cohen d test results, large effect size (3.4375) has been found between groups anger level means.

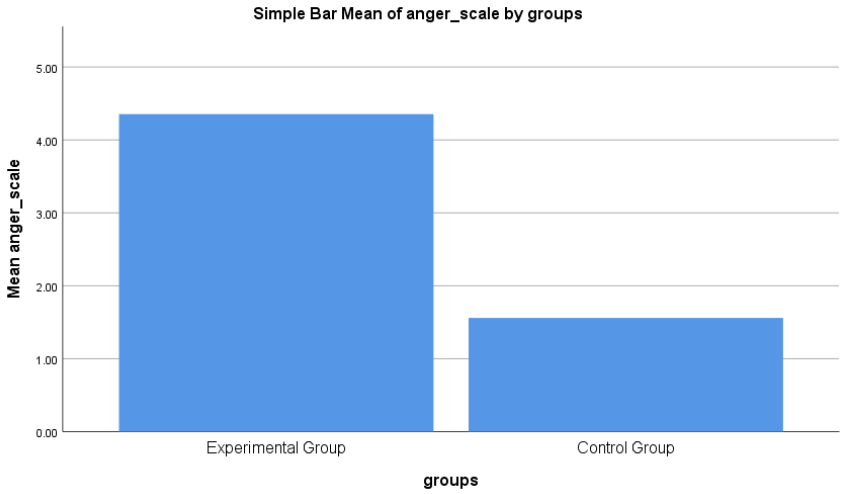


*Figure 8:*Anger Scale

### *3.3.1.2. Happiness*

There was a significant difference *(p<0.05)* between the happiness scale rates of the experimental group *(M=1.15, SD=.65)* and the control group *(M=3.12, SD=1.2).* According to Cohen d test results, large effect size (2.041423) has been found between groups happiness level means.

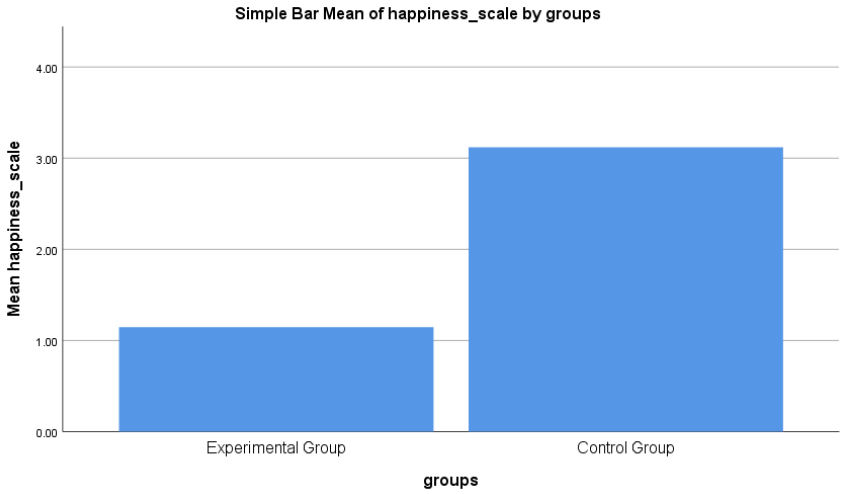


*Figure 9:* Happiness Scale

### *3.3.1.3. Sadness*

There was a significant difference *(p<0.05)* between the sadness scale rates of the experimental group *(M=4.62, SD=.96)* and the control group *(M=2.17, SD=1.02).* According to Cohen d test results, large effect size (2.473612) has been found between groups sadness level means.


*Figure 10:* Sadness Scale

### *3.3.1.4. Fear*

There was a significant difference *(p<0.05)* between the fear scale rates of the experimental group *(M=3.52, SD=1.46)* and the control group *(M=1.6, SD=.98).* According to Cohen d test results, large effect size (1.544175) has been found between groups fear level means.

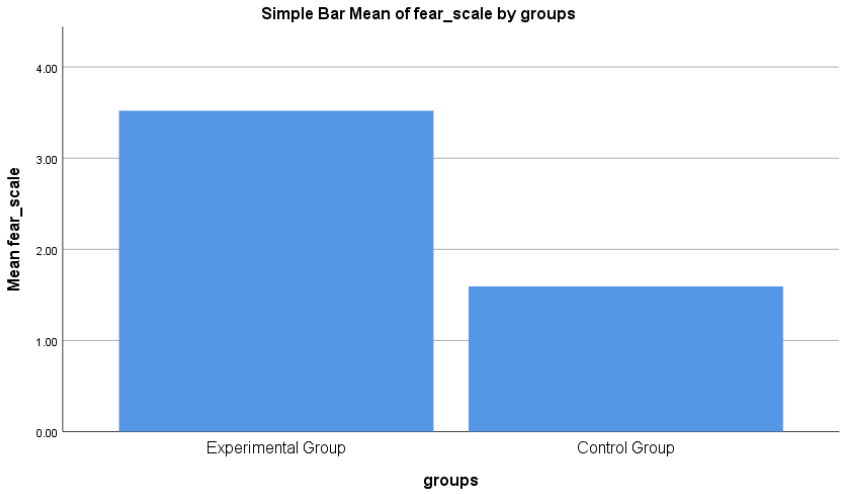


*Figure 11:* Fear Scale

### *3.3.1.5. Disgust*

There was a significant difference *(p<0.05)* between the disgust scale rates of the experimental group *(M=4.63, SD=.1.08)* and the control group *(M=1.14, SD=.60).* According to Cohen d test results, large effect size (3.994903) has been found between groups disgust level means.

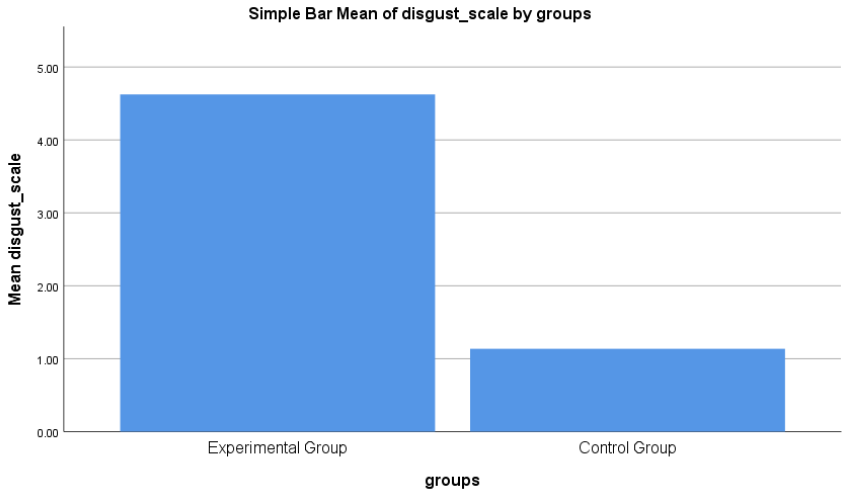


*Figure 12:* Disgust Scale

### *3.3.1.3. Surprise*

There was a significant difference *(p<0.05)* between the surprise scale rates of the experimental group *(M=3.96, SD=1.32)* and the control group *(M=1.61, SD=.91).* According to Cohen d test results, large effect size (2.072879) has been found between groups surprise level means.

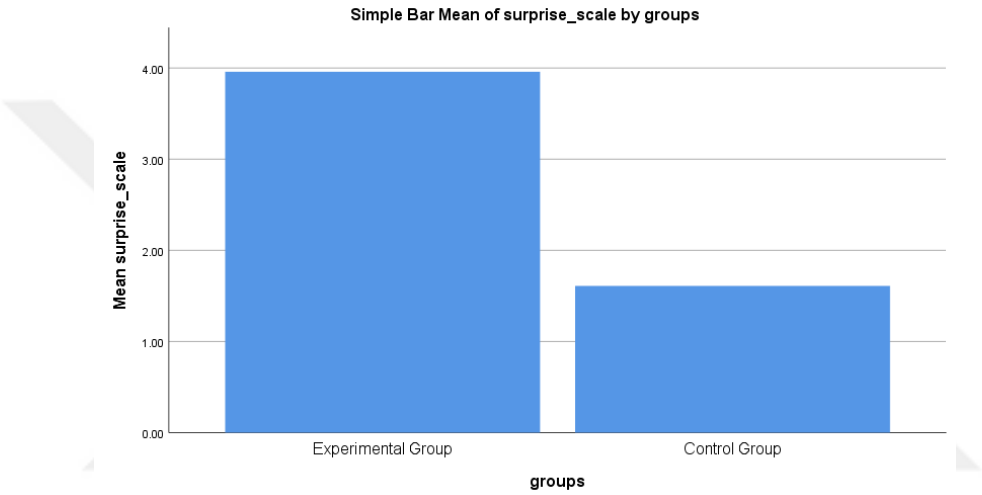


*Figure 13:* Surprise Scale

## 3.2. Accuracy

At first, accuracy means for all items have been analyzed and Independent-Sample T-Test has been applied. There was no significant difference (*p>0.05*) between the experimental group values (*M=0.66, SD=0.13*) and the control group values (*M=0.65, SD=0.14).*

**Table 2**:

*Independent-Samples T-Test for Accuracies*

| **Variable** | **Groups** | *N* | *M.* | *S.D.* | *p* |
|---|---|---|---|---|---|
| **Accuracy** | Experimental | 47 | .66 | .13 | .692 |
| | Control | 60 | .65 | .14 | |

### 3.2.1. Violent Items Analysis Between Groups

Response accuracy for the violent items in the experiment has been measured. An Independent Sample t-test between groups has been applied. There was no significant difference (*p>0.05*) between the experimental group values (*M=0.52, SD=0.03*) and the control group values (*M=0.51, SD=0.02).*

**Table 3***:*

*Independent Samples T Test for Accuracies*

| **Variable** | **Groups** | *N* | *M* | *S.D.* | *p* |
|---|---|---|---|---|---|
| **Accuracies** | Experiment | 47 | .52 | .03 | .742 |
| | Control | 60 | .51 | .02 | |

### 3.2.2. Neutral Items Analysis Between Groups

Response accuracy for the neutral items in the experiment has been measured. An Independent Sample t-test between groups has been applied. There was no significant difference (*p>0.05*) between the experimental group values (*M=.78, SD=0.02*) and the control group values (*M=.78, SD=.02).*

**Table 4***:*

*Independent Samples T Test for Accuracies*

| **Variable** | **Groups** | *N* | *M* | *S.D.* | *p* |
|---|---|---|---|---|---|
| **Accuracies** | Experiment | 47 | .79 | .02 | .800 |
| | Control | 60 | .78 | .02 | |

### 3.2.3. Violent and Neutral Items in The Experimental Group

Response accuracy for the neutral items in the experiment has been measured. A Paired Sample t-test between items has been applied. There was **significant** difference (*p<0.05*) between response accuracies for violent items (*M=0.52, SD=0.22*) and neutral items (*M=0.79, SD=0.15)*; t (46) =-6.638, p=0.000.

**Table 5:**

*Paired Samples T Test for Accuracies*

| **Variable** | **Items** | *N* | *M* | *S.D.* | *p* |
|---|---|---|---|---|---|
| **Accuracies** | Violent | 47 | .52 | .22 | <.001 |
| | Neutral | 47 | .79 | .15 | |

### 3.2.3. Violent and Neutral Items in The Control Group

Response accuracy for the neutral items in the experiment has been measured. A Paired Sample t-test between items has been applied. There was also a **significant** difference (*p<0.05*) between response accuracies for violent items (*M=.51, SD=0.2*) and neutral items (*M=.78, SD=0.17)*; t (59) =--9.023, p=0.000.

**Table 6***:*

*Paired Samples T Test for Accuracies*

| **Variable** | **Items** | *N* | *M* | *S.D.* | *p* |
|---|---|---|---|---|---|
| **Accuracies** | Violent | 60 | .51 | .20 | <.001 |
| | Neutral | 60 | .78 | .17 | |

## 3.3. Reaction Times

### 3.3.1. Violent Items Analysis Between Groups

Reaction times for the violent items in the experiment have been measured. An Independent Sample t-test between items has been applied. Results indicate that there was no significant difference between the experimental group (*M=942.708, S.D.= 174.8337*) and the control group (*M=975.550, S.D.=152.5777).*

**Table 7:**

*Independent Samples T Test for Reaction Times*

| **Variable** | **Groups** | *N* | *M* | *S.D.* | *p* |
|---|---|---|---|---|---|
| **Reaction Times** | Experiment | 47 | 942.708 | 174.8337 | .302 |
| | Control | 60 | 975.550 | 152.5777 | |

#### *3.3.1.1. Violent Items Analysis for Correct Answers*

Here the reaction times of the correct answers for the violent items in the experiment have been measured. An Independent Sample t-test between items has been applied. Results indicate that there was no significant difference between the experimental group (*M=926.405, S.D.=308.1098),* and the control group (*M=994.480, S.D.=172.3988).*

**Table 8:**

*Independent Samples T Test for Reaction Times*

| **Variable** | **Groups** | *N* | *M* | *S.D.* | *p* |
|---|---|---|---|---|---|
| **Reaction Times** | Experiment | 47 | 926.405 | 308.1098 | .149 |
| | Control | 60 | 994.840 | 172.3988 | |

### 3.3.2. Neutral Items Analysis Between Groups

Reaction times for the neutral items in the experiment have been measured. Independent Samples t-test between groups has been applied. There was no significant difference between the experimental group *(M*=904.524, *S.D.*= 253.4281*)* and the control group *(M*=905.852, *S.D.*= 238.1975).

**Table 9:**

*Independent Samples T Test for Reaction Times*

| **Variable** | **Groups** | *N* | *M* | *S.D.* | *p* |
|---|---|---|---|---|---|
| **Reaction Times** | Experiment | 47 | 904.524 | 253.4281 | .993 |
| | Control | 60 | 905.852 | 238.1975 | |

#### *3.3.2.1. Neutral Items Analysis for Correct Answers*

Here the reaction times of the correct answers for the neutral items in the experiment have been measured Independent Samples t-test between groups has been applied. There was no significant difference between the experimental group *(M=916.579, S.D.=. 172.9881)* and the control group *(M=915.694, S.D.= 139.3953)*.

**Table 10***:*

*Independent Samples T Test for Reaction Times*

| **Variable** | **Groups** | *N* | *M* | *S.D.* | *p* |
|---|---|---|---|---|---|
| **Reaction Times** | Experiment | 47 | 916.579 | 172.9881 | .98 |
| | Control | 60 | 915.694 | 139.3953 | |

### 3.3.3. Violent and Neutral Items Comparison Within Groups

#### *3.3.3.1. Experimental Group*

Reaction times for all the items in the experiment have been measured. Here we compared the reaction times to the violent items and neutral items in the experimental group. Paired Samples t-test between groups has been applied. There was no significant difference in the scores for the reaction times to violent items *(M=943.296, S.D.=173.0118)* and the reaction times to neutral items *(M= 914.192, S.D.=166.146)*; t (47) =1.501, p=0.140.

##### *3.3.3.1.1. Experimental Group with the Correct Answers*

Reaction times for all the correct answers in the experiment have been measured. Independent Samples t-test has been applied. There was no significant difference in the scores for the reaction times to violent items *(M= 926.405, S.D.=308.1098)* and the reaction times to neutral items *(M= 916.579, S.D.=172.9881)*; t (46) =1.501, p=0.846.

#### *3.3.3.2. Control Group*

Reaction times for all the items in the experiment have been measured. Here we compared the reaction times to the violent items and neutral items in the neutral group. Independent Samples t-test has been applied. There was a significant difference in the scores for the reaction times to violent items *(M= 975.628, S.D.=153.8862)* and the reaction times to neutral items *(M= 914.9645, S.D.=135.9313)*; t (58) =3.567, p=0.01.

##### *3.3.3.2.1. Control Group with the Correct Answers*

Reaction times for all the correct answers in the experiment have been measured. Independent Samples t-test has been applied. There was a significant difference in the scores for the reaction times to violent items *(M=994.840, S.D.=172.3988)* and the reaction times to neutral items *(M= 915.694, S.D.=139.3953)*; t (59) =3.596, p=0.001.

### 3.3.4. False Positives

Here the mean of incorrect responses and reaction times for the violent items which were not in the memory set were compared. Data were not distributed normally, therefore, Independent-Samples Mann-Whitney U Test has been used. There was no significant difference between the means of incorrect answers for the violent items between the experimental group *(Mdn=1.5)* and the control group *(Mdn=2), U=971.5.0, p=.698.*

For the reaction times data, the Independent Samples t-test has been applied. There was no significant difference *(p>0.05)* between the reaction times of the experimental group *(M=.90, SD=.25)* and the control group *(M=.95, SD=.26)* for the violent items.

# 4. DISCUSSION

In this study, we examined how emotions affect other cognitive functions to provide supportive data for the integration theory of emotion and cognition. Many studies have shown that emotions affect working memory; however, Kensinger and Corkin (2003) have also shown that this effect is not consistent. We conducted an experiment to see whether emotional load, which is a negative mood-induced video, will affect visual working memory performance in terms of accuracy and reaction times. Results of this study also showed the inconsistency of the effect of emotions on working memory performance.

At first, we aimed to be sure that there was no difference in violent tendencies between the experimental and control group, and as expected we found no difference between the groups. Whereas the experimental group has seen a negative mood-inducing video, the control group has seen a neutral-happy mood-inducing video. We compared the emotion levels between groups and found that the experimental group had significantly higher anger (4.5), sadness (4.7), fear (3.5), disgust (4.7), and surprise level (4). According to these results, we can say that the experimental group was induced negative mood, and the control group was induced happy mood. This way, we became sure that the results were dependent on our manipulation check because mood induction was successful. We also did Cohen d tests to see which emotion is affected the most by our manipulation. Results show that anger and disgust has been affected most by the emotion inducing video.

## 4.1.Accuracy

Working memory performances were usually evaluated with accuracy and reaction times. We aimed to check the accuracy rates for all items between the two groups. Results showed that there was no significant difference for all items between groups. According to this result, we see that the negative and positive emotions did not affect working memory

performance in accuracies. After that, we checked if there was a difference in accuracies for violent items between groups. We found that negative and positive emotions also did not affect the accuracy rates for violent items. We also found similar results for the neutral items. However, descriptive data show that accuracy means were higher in neutral items than in violent items. It shows that participants gave more correct answers to neutral items. In both groups, it has been found that recognition of threatening stimuli was more challenging than neutral stimuli, independent of mood or emotional states. Other than that, we compared accuracy means for violent items and neutral items inside groups. Accuracy means for neutral items were significantly higher than the violent items in the experimental group. However, similar results were found in the control group. It shows that working memory performance was not affected by mood induction in terms of accuracies. Ohman et al. (2001) found that we tend to attend to threatening stimuli rather than neutral stimuli. However, our findings showed that participants, whether they were induced negative or positive mood, attended more to neutral items. So, there has been a repressing effect in working memory for violent/threatening stimuli in both groups. However, these findings are consistent with the study of Kensinger and Corkin (2003). They also found out that participants working memory performance in accuracy decreased for emotional items in almost all the working memory tasks. Also, Xie & Zhang (2016) showed that negative emotion induction does not enhance the quantitative performance of the working memory, it is more related to qualitative performance. Robinson (2007) found that negative-high arousal emotions led participants to the threatening stimuli, and positive-high arousal emotions led them to the rewarding stimuli. However, in our study, we showed that negative emotions did not direct participants' attention to the threatening stimuli.

Our findings were consistent with the study of Storbeck & Maswood (2016) which showed that whereas a happy mood increased verbal and spatial working memory

performance, a sad mood did not affect both types of working memory performances. However, the results again show inconsistency for emotional effects, Zhang et al. (2017) showed that results are changing depending on the working memory capacity of participants, while positive and negative emotions have improved the working memory performance in the high working memory capacity group, the results were right opposite for the low-capacity group.

### 4.2.Reaction Times

Even in our daily lives, it is likely that our attention to the objects in our environment is affected by the mood or emotional state we have. Effect of emotions on working memory performance differentiates in reaction times and accuracies. It has been found in previous studies that whereas emotions enhance accuracy means, they impair the reaction times performance (Kensinger, 2007). We expected faster reaction times for the violent items in the experimental group due to biasing after emotional induction. We expected that negative mood can direct attentional sources toward threatening stimuli in the experiment as Parrott et al. (2005) found. At first, we checked the reaction times for the violent items between the experimental and control group, and we found no significant difference between them

This shows that negative mood-induced participants gave a faster reaction to the violent items, even though the responses they gave were not correct and this indicates that participants tend to respond faster to the violent items. This means that the retrieval function of the working memory is efficient for emotional stimuli.

After that, we checked the reaction times for violent items in the correct answers. Our findings show negative mood-induced participants have faster response times for violent items in general even though the difference was not significant. To accept as working memory performance, we checked reaction times in correct answers. In correct answers,

response times means between violent and neutral items came closer. However, the reaction times of the correct answers are slower than in general; therefore, this shows that the negative emotions led participants to respond to all violent items, including false positives (that are not in memory sets) faster; however, for the relevant stimuli (violent items which exist in memory sets) this gap closed, and participants' reaction times became slower. This change did not occur for the neutral items as it did for the violent items. Reaction times for the neutral items between groups showed no significant difference and means were almost identical. Then, we checked the reaction times for the correct answers for neutral items and found no significant difference between groups and there was no change at all.

The difference between the reaction time means of the experimental group for violent items and the reaction times for the correct answers is more than the difference in the control group. We found that reaction times for the violent items in the experimental group are slower than for neutral items without considering the correct answers. However, in the correct answers, we found that negative mood-induced participants gave slower reaction times for the violent items which means that emotional load and threatening stimuli impaired the working memory performance for reaction times. The same effect did not occur for the neutral items. Results show that reaction times for neutral items were similar to correct and general answers.

And finally, we checked the reaction times for violent items with wrong answers which are called false positives. There was no significant difference between groups; however, descriptive data show that reaction times for the violent items were faster in the experimental group.

Curci et al. (2013) also found that exposure to negative emotional experiences impairs working memory performances and showed that this effect does not only stem from the traumatic experiences, but also daily situations cause these results. This has been supported

by Berggren et al. (2017), who showed that anxiety and stress are impeding effects on visual working memory. A study by Fairfield et al. (2015) also shows that participants' accuracy tends to impair for longer emotional words due to limited sources. Padmala et al. (2011) showed with conflict adaptation tasks that emotion interacts with executive functions in a way of goal-directed behaviors.

It has been shown in previous studies that participants' negative mood has an impairing influence on working memory performance (Spies et al., 1996). Therefore, in normal working memory experiments with negative mood induction which have emotion irrelevant content, impairment in working memory performance is highly expected, but when the task is to detect negatively valenced stimuli, this impairment disappears. Also, the vast majority of the studies were examining how negative emotions or moods affect working memory performance, however, working memory tasks usually do not have affective stimuli. Our study is an example of both negative emotion induction and threatening stimuli during the experiment. Because emotions influence which information to be held online and attended to through visual selective attention, we wanted to show that negative mood should allocate attentional sources and retrieval for threatening/violent stimuli.

We found that negative and neutral emotion induction did not show a difference in working memory performances in terms of accuracy and reaction times. But for both groups, accuracy means for violent stimuli were lower than for neutral stimuli. On the other hand, reaction times for correct answers to the violent stimuli were faster than neutral stimuli in both groups. This can be interpreted as while processing the emotional stimuli attention repress the affective information; however, during the retrieval, working memory gives priority to the affective stimuli by providing faster reaction times to the participants.

The results of this study can be explained by this methodological difference. As it has been mentioned before, even though the general results are not consistent, it is likely that negative emotions are competing for executive sources which cause worse working memory performances. However, with the negative emotional induction, we found that these results can be balanced. The importance of the emotional effect cannot be understood with only one aspect of the examination. We wanted to show that the integration of emotion and cognition should be examined in a multi-dimensional way.

### 4.3.Limitations

One of the main problems of my study is the difficulty level of the working memory tasks. Results showed that participants found the working memory task challenging and they reported this verbally as well. In the formal Recency-Probe Paradigm (Monsell, 1978), there are 6 letters to test the working memory performance. I have increased this number to 8 items based on a study that claims working memory performance capacity can increase for real-life objects (Brady et al., 2016). However, in our study, participants found the task challenging and because of this, accurate answers for all the items radically decreased. Other than that, the negative mood-inducing video might have an exhausting effect on participants which may cause low accuracy rates. 2 seconds for memory items and 2 seconds for recognition tasks were short for the participants. With more correct response data, statistical analysis can be different. Instead of this, we could put 6 items or make the recognition task 3 seconds to improve working memory performance for accuracies and check only response times. Also, participants with the violent background and individual differences in working memory are possible limitations. One important limitation is to lack of information about participants' working memory performance and therefore categorization of participants according to this information.

### 4.4.Future Studies

As we have emphasized in the limitations part, this study can be repeated with the experimental setup which leads to fewer accuracy mistakes. Besides, in another study, working memory tasks can match with the anger scale results, or participants with anger management problems can be used. To focus only on the emotion of anger, this study can be replicated with pictures from IAPS (International Affective Picture System). Also, this study can be repeated with eye-tracking methods to check how emotions affect our perceptual process. For emotion-inducing, shorter stimuli can be used. Another thing for future studies is to categorize participants according to their working memory capacity. Because in several studies it has been shown that these effects can be modulated by the working memory capacity. I believe that mood-induction and affective working memory and attention experiments should be focused more.

# 5. CONCLUSION

The relationship between emotions and cognition has a critical role in many aspects to understand executive functions. So far, emotion studies have shown inconsistent results depending on methodology or emotions which are difficult to define and measure. We found that the effect of emotions on cognitive functions shows differentiation depending on methodology and emotions. We found that working memory performance has changed for emotional stimuli; however, emotion induction did not affect the working memory performance in a way of enhancement or impairment. Also, the processing and retrieval of affective information differentiated independent from emotional mood induction. Examining the effect of emotion on cognitive functions should be more domain-specific. Also, it was important to combine emotional induction with working memory and emotional content working memory tasks. This combination of emotional loads is balancing the working memory performances, which is normally expected worse or better in the case of just one load. However, as has been shown in Kensinger and Corkin (2003), the effect of emotions on working memory performances is not consistent whether in accuracy or reaction times. We showed that in order to explain how emotion and cognition integration is working, more distinguished and complex studies are necessary. This effect can be modulated depending on which emotion will be used, how this mood will be induced and measured, and if there will not be a mood induction, which sort of emotional stimuli will be used in the cognitive tasks. Even though at first, we mainly focused on the emotional state of anger, the participant report for the sadness scale showed significant differences as well. Therefore, these results can be examined under more properly under the negative emotions. Although this study cannot provide neuroscientific data, the integration of emotions and cognition can be understood by the complexity of emotional effects on working memory.

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## APPENDIX A: VIOLENCE TENDENCY SCALE

ŞİDDET EĞİLİM ÖLÇEĞİ EK-1

Aşağıda bir insanın yaşamındaki çeşitli tepkilerini ve düşüncelerini ifade eden cümleler yer almaktadır. Her cümlenin sizin tepki ve düşüncelerinize uygun olup olmadığını belirtiniz.

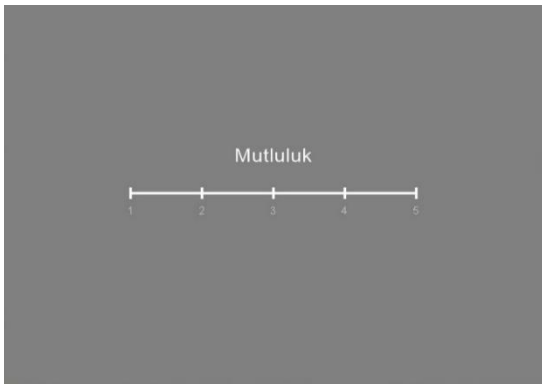
| | | **Hiç uygun değil** | **Biraz uygun** | **Uygun** | **Çok uygun** |
|---|---|---|---|---|---|
| **1** | Hoşuma gitmeyen bir olay karşısında hemen sinirlenirim | | | | |
| **2** | Doğru olduğuna inandığım konularda eleştirilmek beni sinirlendirir | | | | |
| **3** | Rahatsız olduğum durumlar karşısında sinirlendiğimde kendimi kontrol edemiyorum | | | | |
| **4** | Duygusal yada fiziksel rahatsız edildiğimde fiziksel olarak karşılık verme isteği duyarım | | | | |
| **5** | Sinirli olduğumda bir şeyleri kırma isteği duyarım | | | | |
| **6** | Arkadaşlarım,annem,babam vb. insanlarla çok sık tartışmaya girerim | | | | |
| **7** | Hak etmiş olanlara layık oldukları ceza verilmelidir | | | | |
| **8** | Eğer beğenmediğim bir şey olursa en yakınımla bile tartışırım | | | | |
| **9** | Bence hayvanların av maksadıyla vurulmasında sakıncası yoktur | | | | |
| **10** | Diğerlerinin saldırılarına karşı güçlü bir arkadaş grubu mutlaka olmalıdır | | | | |
| **11** | Eğer saldırıya uğramışsam aradan geçen zamana bakmaksızın aynı şekilde karşılık veririm | | | | |
| **12** | İnsan çevreden gelecek tehditlere daima hazır olmalıdır | | | | |
| **13** | Bu dünyada en önemli şey diğerlerinden güçlü olmaktır | | | | |
| **14** | Sık sık kavga ederim | | | | |
| **15** | Bazı insanlara karşı zor kullanılabileceğini inanırım | | | | |
| **16** | Bazı hallerde insanlara karşı zor kullanılabileceğine inanırım | | | | |
| **17** | Kavgaları seyretmek hoşuma gider | | | | |
| **18** | İnsanların benden korkması hoşuna gider | | | | |
| **19** | Bazen başkalarına zarar verme isteği duyarım | | | | |
| **20** | Sokakta başıboş dolaşan hayvanlar ortadan kaldırılmalıdır | | | | |

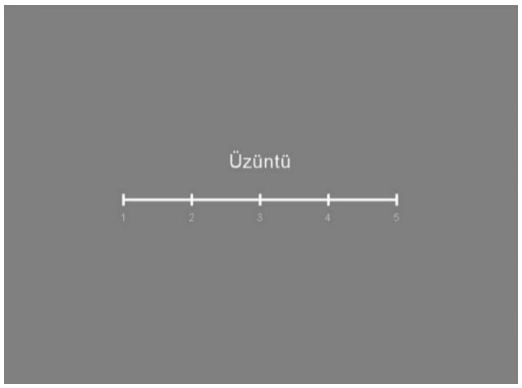
**APPENDIX B: ITEMS**

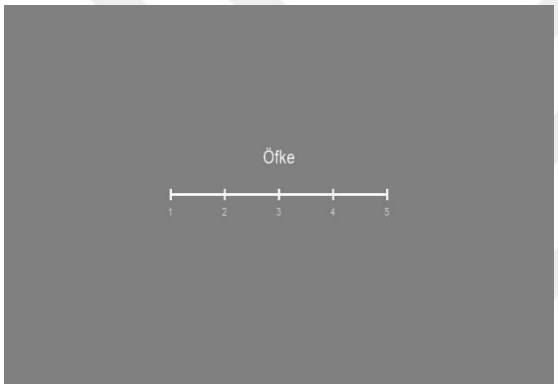
**VIOLENT**

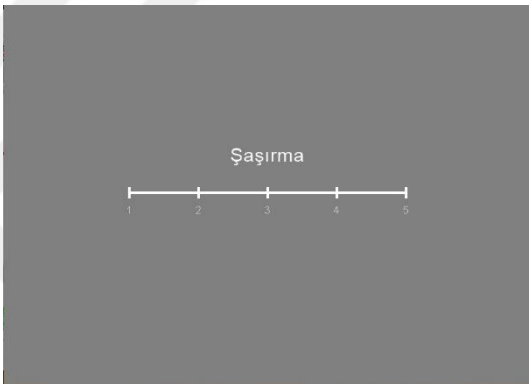
**NEUTRAL**

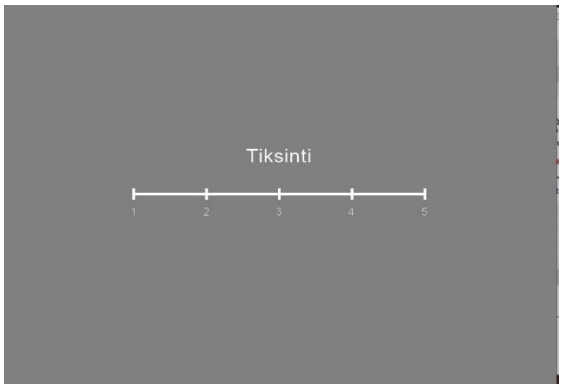
## APPENDIX C: PAUL EKMAN'S UNIVERSAL EMOTION SCALES

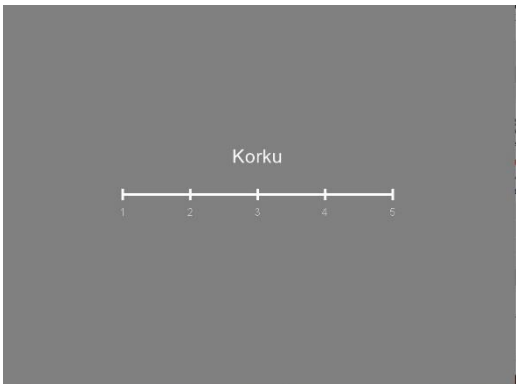


## APPENDIX D: CONSENT FORM

**Gönüllü Katılım Formu**

Araştırmaya katılım sağladığınız için teşekkür ederiz. **Dr. Ögr. Üyesi Sara Saban** danışmanlığında Bilişsel Bilimler Yüksek Lisans öğrencisi **Emre Gözütok** tarafından yapılan bu tez çalışması, duyguların bilişsel fonksiyonlara etkisini ölçmeyi hedeflemektedir.

Çalışma bilgisayar ortamında olacak. İşler bellek süreçlerini büyük bir grubun ortalaması olarak inceleyeceğim. Katılacağınız çalışma yaklaşık 10 dakika sürmektedir. Öncelikle sizden bir form doldurmanız istenecek. Size ait her türlü bilgi gizli tutulacaktır, yayın ve raporlarda bilgileriniz kesinlikle kullanılmayacaktır. Toplanan veriler bireysel olarak değerlendirilmeyecek, grup verileri istatistiksel analiz için kullanılacaktır. Çalışmaya yalnızca bir kez katılacaksınız ve katılım esnasında herhangi bir nedenden ötürü kendinizi rahatsız hissederseniz, deneyi istediğiniz aşamada bırakmakta özgürsünüz. Bırakmak istediğinizde deneyi uygulayan kişiye haber vermeniz yeterli olacaktır.

Çalışma hakkında veya kendi haklarınız ile ilgili daha fazla bilgi almak için Psikoloji bölümü öğretim üyesi Sara Saban (e-posta: ssaban@yeditepe.edu.tr) ve Bilişsel Bilimler Yüksek Lisans programı öğrencisi Emre Gözütok (e-posta: emre.gozutok@std.yeditepe.edu.tr, telefon: 0535 3494850) ile iletişim kurabilirsiniz.

Bilgilendirilmiş Gönüllü Olur Formundaki tüm açıklamaları okudum. Bana, yukarıda konusu ve amacı belirtilen araştırma ile ilgili yazılı ve sözlü açıklama aşağıda adı belirtilen araştırmacı tarafından yapıldı. Araştırmaya gönüllü olarak katıldığımı, istediğim zaman gerekçeli veya gerekçesiz olarak hiçbir yaptırıma maruz kalmadan araştırmadan ayrılabileceğimi ve kendi isteğime bakılmaksızın araştırmacı tarafından araştırma dışı bırakılabileceğimi biliyorum. Söz konusu araştırmaya, hiçbir baskı ve zorlama olmaksızın kendi rızamla katılmayı kabul ediyorum.

**Gönüllünün;**

Katılımcı Numarası

İmzası: Tarih:

**Araştırma Ekibinde Yer Alan ve Yetkin Araştırmacının;**

Adı Soyadı: