THE BLOCKING EFFECTS ON OBSERVATIONAL LEARNING OF FEAR

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THE BLOCKING EFFECTS ON OBSERVATIONAL LEARNING OF FEAR

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This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

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ABSTRACT

THE BLOCKING EFFECTS ON OBSERVATIONAL LEARNING OF FEAR

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Blocking effect represents the disruption of association between a novel stimulus that is added next to a conditioned stimulus which already predicts an unconditioned stimulus, and it is especially remarkable due to its relation to prefrontal cortex. In recent years, the approaches attempting to explain the mechanisms of fear learning, emphasize on the similarity of the direct and observational fear learning mechanisms and the involvement of prefrontal cortex in both. Present study aims to investigate the blocking effects in observational fear learning. A model was exposed to acquisition and blocking procedures which were administered in a discriminative classical conditioning paradigm while the stimuli

presentations and the responses of the model were being recorded on a video. Participants were presented with the video. Afterwards, in the test phase, the single stimuli were presented directly to the participants and the responses were used in the investigation of blocking effects. In total, valid data from 33 participants were collected. Skin conductance responses and *US* expectancy levels were obtained in the test phase. The responses towards stimuli which were presented alone in the acquisition phase were compared with the stimuli which were added next to them later. Although blocking effect was not observed in skin conductance responses, analyses on *US* expectancy levels revealed blocking effects. Results were discussed in the scope of direct and observational fear learning pathways and the neural mechanisms.

Keywords: observational fear learning, blocking effect, skin conductance response, *US* expectancy

ÖZET

KORKUNUN GÖZLEM YOLUYLA EDİNİMİNDE BLOKLAMA ETKİLERİ

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Bloklama etkisi, halihazırda koşulsuz uyarıcının gelişini güvenilir bir biçimde yordayan bir koşullu uyarıcıya eklenen yeni bir uyarıcının koşullu nitelikler kazanmasında gözlenen güçlüğü ifade etmektedir ve özellikle ön beyin ile olan ilişkileri bakımından dikkat çekicidir. Son yıllarda korkunun ediniminde rol oynayan mekanizmaları açıklamak üzere ortaya atılan yaklaşımlar, korku edinim mekanizmalarının benzerliği ve ön beynin korkunun hem doğrudan hem de gözlem yoluyla ediniminde oynadığı role vurgu yapılmaktadır. Sunulan çalışma ile korkunun gözlem yoluyla ediniminde bloklama etkilerinin incelenmesi amaçlanmıştır. Üzerinde ayırt edici klasik koşullama yordamı kapsamında koşullu korku

tepkilerinin ediniminin ve bloklamasının gerçekleştirildiği bir modele bilgisayar ekranından sunulan uyarıcılar ile bunlara verdiği tepkiler bir video kamera ile kaydedilmiştir. Katılımcılara önce bu video kaydı izletilmiştir. Test aşamasında ise, uyarıcılar katılımcıya doğrudan ve tek başına olmak üzere sunulmuş ve bu uyarıcılara verilen tepkiler bloklama etkilerinin incelenmesinde kullanılmıştır. Toplam 33 katılımcıdan geçerli veri elde edilmiştir. Test aşamasında alınan deri iletkenliği ve *US* beklentisi ölçümleri kaydedilmiştir. Karşılaştırmalar, ilk aşamada tek olarak sunulan uyarıcılar ile her birine sonradan eklenmiş uyarıcılar arasında yapılmıştır. Deri iletkenliği tepkilerinde bloklama etkisi gözlenmemekle beraber, *US* beklentisine dair analizler bloklama etkilerini ortaya koymuştur. Sonuçlar korku öğrenmesinde direkt ve gözlem yoluyla öğrenme yolakları ve bu yolaklara ait sinirsel mekanizmalar kapsamında tartışılmıştır.

Anahtar Kelimeler: gözlem yoluyla korku öğrenmesi, bloklama etkisi, deri iletkenliği tepkisi, *US* beklentisi

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CHAPTER 1: INTRODUCTION

The main goal of the present thesis is to investigate blocking effect in fear conditioning by using observational learning paradigm. Prior to stating main hypotheses, observational learning and its mechanisms, history of observational fear learning, mechanisms of observational fear learning and blocking phenomenon will be introduced.

1.1 Observational Learning and Its Mechanisms

Observational learning refers to learning by observing a sequence of events and responses of others to those events, rather than directly experiencing the situation. Learning would have required enormous labor, and resulted in many harmful consequences for the individual, if direct experiences were the only ways of learning. Instead, individuals are spared needless errors by learning from experiences of others by observing the consequences of their responses, before performing any behavior.

One of the most influential early research on observational learning was the famous Bobo doll experiment by Bandura, Ross, and Ross (1961). Typically,

Bandura and his colleagues studied the aggressive behavior of the children after watching an adult model act aggressively to Bobo doll, an inflatable toy model made of a soft plastic material in approximate size of a preschool child. In a widely known version of the study, preschool children were assigned to the three conditions where they observed a model showing either aggressive or non-aggressive behavior towards a Bobo doll, and a control condition where children had no prior exposure to the model. In all conditions, the number of male and female subjects was equal and participants in experimental conditions observed either the same-sex or opposite sex models, creating 8 experimental groups in total. While the children who had observed the non-aggressive model simply ignored the existence of Bobo doll in the toy room, the children in the aggressive model condition showed an increased level of responding towards the doll, and majority of those responses were aggressive in nature (e.g. aggressive behavior, aggressive verbal responses). Response measures were classified as imitative (physical aggression, verbal aggression, non-aggressive comments), partially imitative (aggression towards other toys, sitting on Bobo doll but not performing aggressive behavior), and non-imitative (physical and verbal aggression that were not in model's repertoire, aggressive gun play). Participants in the non-aggressive condition and the control group only rarely performed aggressively while participants who observed aggressive model produced aggression that was substantially identical with model's behavior. Results of the study revealed that observing a model might be one of the effective ways of eliciting certain responses that are unlikely to occur otherwise.

As an early explanation for mechanisms of observational learning, Bandura asserted that the occurrence of an observationally acquired behavior might be

implemented in four stages: Attentional processes, retention processes, motor reproduction processes, and motivational processes (Bandura, 1977). Attentional processes are explained as the determinant of what is selectively observed in a crowd of modeling influences, and what is extracted from such exposures. Characteristics of the modeling stimuli such as the exposure frequency and functional value, and the characteristics of the observer such as sensory capacities and arousal level are considered critical attentional determinants. Second stage is described as retention processes, because in order for observers to profit from model's behavior when it is no longer present, they need representations of that behavior in memory. Symbolic coding and rehearsal serve as important memory aids facilitating observational learning. Third stage of observational learning, motor reproduction processes, involves bringing symbolic representations into actions. Being able to produce appropriate actions requires physical capabilities, repetition and feedback. However, learning doesn't always result in performance, because individuals are more likely to act out rewarded behavior and not the punished behavior. This doesn't mean that acquisition did not occur; hence, the last component of observational learning is motivational processes. If there are no proper reinforcements, observers may not have the motivation to reproduce the learned behavior. According to this view, observers need to observe a model, encode modeled events for memory representation, be physically able to perform and have sufficient incentive in order to match the behavior of a model.

In the late 19th century, the common belief was that observational learning involved so complex mechanisms that were unlikely to be found in nonhuman animals (Pallaud, 1984). This point of view was proven wrong when systematic

research on observational learning began. One of the early studies showing observational learning in nonhuman animals was conducted by Church in 1957. Church trained three rats to go left and three rats to go right in a T-maze for reaching water. Six test subjects were given 150 trials where they reached water if they followed the leader rats. Results of the experiment showed that test subjects gradually learned to follow the leader. Second phase of the experiment was conducted with an incidental cue, where two light sources were planted on each side of the T-maze. Half of the leaders would run to the direction of the light whereas the other half would run to the opposite direction of the light; making the presence or absence of the light an incidental cue. Hundred trials were run with test subjects where they reached water if they followed the leader, as in the first experiment. To test the learning of incidental cue, the same procedure was conducted for 20 trials without the presence of a leader. On the 77 percent of the trials, subjects went to the side marked by the cue (presence or absence of the light) to which the leader had been going. This research showed that behavior can be socially acquired in nonhuman animals and can be lasting at the absence of the model.

Studies that showed observational learning in animals challenged the idea of observational learning being human-specific. Following these revolutionary findings, many studies have led to hypotheses regarding the associative processes underlying observational learning. Pallaud (1984) explained these hypotheses under four titles; local enhancement hypothesis, mediate response hypothesis, sensory preconditioning hypothesis, and imitation of the model's response.

Local enhancement hypothesis claims that the observer learns because the model's activity draws observer's attention towards a particular site in the

environment. Lubow and colleagues (1975; as cited in Pallaud, 1984) provided a model on how local enhancement works; if responses are followed by an environmental change, stimulus salience will be maintained, therefore drawing the attention of the observer but lacking of the change following the responses will result in a decrement in the salience of conditioned stimulus.

According to mediate response hypothesis, during the observation phase, observer produces mediate responses, which are suitable responses even if the observer cannot reach the reinforcement. An association takes place between these mediate responses and the stimuli which precede the dispensing of the reinforcer, which in case of observational learning, is the model. In this case mediate responses become mediate stimuli and elicit responses similar to the behavior of the model, when given the chance.

Sensory preconditioning hypothesis explains observational learning in two phases; observation phase and test phase. According to this hypothesis during the observation phase, the organism can associate the goal (unconditioned stimulus) with the conditioned stimulus and during the test phase the conditioned stimulus acquires the ability to elicit behavior.

Imitation hypothesis, like sensory preconditioning hypothesis, relies on an association that occurs in the observation phase. This time it is claimed that the association occurs between the goal and a pattern of response of the model. By comparing these four hypotheses, Pallaud concludes that mechanisms responsible for observational learning are associative processes occurring during the observation.

In the following years, after studies suggesting direct and observational learning may operate on similar associative processes (e.g. Mineka and Cook, 1993)

and the new categorization scheme on direct learning provided by Rescorla (1988); Heyes (1994) proposed three alignments on how observational learning works. Heyes summarized the aforementioned categorization scheme used by investigators of direct learning at the time (Figure 1), and suggested that observational learning phenomena could be subsumed within the same categorization scheme.

Figure 1

First of the three alignments proposed is stimulus enhancement with single stimulus learning, which is when observation of a model exposes the observer to a single stimulus, stimulus enhancement occurs and this exposure elicits a change in the observer's behavior. An example for enhanced stimulus exposure resulting in matching behavior is revealed by Galef and Beck (1985) when they showed rats prefer the food that has been scent marked by a conspecific (as cited in Heyes, 1994). Another category as depicted by Heyes is observational conditioning with Pavlovian conditioning, in which observation of a model exposes the observer to a stimulus-stimulus relationship. In this kind of learning, the unconditioned response of a model acts as an unconditioned stimulus for the observer and the observer learns the association between the unconditioned stimulus and the stimulus that the model reacts to, as shown by Galef in 1988 and Whiten, and Ham in 1992 (as cited in Heyes, 1994). Finally, the last category proposed is observational learning with instrumental conditioning, which is when observation of a model exposes the observer to a reinforcer-response relationship. Heyes, Jaldow, and Dawson (1993) showed that rats detect the relationship between a response and reinforcer by observing conspecific

models pushing a joystick and receiving reward (as cited in Heyes, 1994). By proposing these three categorizations of observational learning which are stemming from categories of direct learning; it is suggested that the underlying mechanisms of both direct and observational learning are similar.

Both Pallaud (1984) and Heyes (1994) emphasize on the adaptive consequences of observational learning. They claim that the capacity for observational learning is adaptive due to its obvious survival value. As a matter of fact, findings of many studies conducted with various species such as pigeons (Sherman, 1969), macaques (Myers, 1970), and rats (Will et al., 1974) have supported the idea of adaptive advantage of observational learning (as cited in Pallaud, 1984). After all, organisms can successfully avoid a threat just by learning through observing how others deal with the threat, and that in turn, would increase the chances of survival.

In addition to its evolutionary significance, observational learning constitutes a fertile ground for the development of many fear related clinical conditions. As it has been shown recurrently, a direct experience with a traumatic event or an object of fear is not necessary to form a phobic condition, indirect experiences (i.e. observations) may also be able to condition fear related reactions (Mineka and Cook, 1993). Therefore, a better understanding of the mechanisms of observational learning is of importance to develop more effective preventions and interventions to clinical presentations of fear.

Over the years, many research focused on observational fear learning and the mechanisms that underlie. Bandura argued that “both direct and vicarious

conditioning processes are governed by the same principle of associative learning, but they differ in the source of emotional arousal" (as cited in Mineka and Cook, 1993). After Rachman (1977) suggested that fear can be acquired by three pathways: Direct conditioning, observational learning and by instruction; it has become crucial to investigate if these pathways are similar or completely separate from each other. Studies, to this day, have consistently supported Bandura's suggestion that both direct and observational fear learning were driven by the same associative mechanisms.

1.2 History of Observational Learning of Fear

Historically, fear learning was thought to be a result of direct conditioning in which organisms associate a conditioned stimulus (*CS*) with an unconditioned stimulus (*US*) that elicits a fear response (unconditioned response: *UR*) naturally. As a result of this association between *CS* and *US*, *CS* would come to elicit fear responses (conditioned response: *CR*), when it is experienced on its own (Askew and Field, 2008). However, the studies conducted during early sixties revealed that fear learning was not limited to direct conditioning. Indeed, Berger (1962) demonstrated that individuals were able to learn to associate the *CS* with model's response, and they showed increased autonomic responses (e.g. skin conductance responses (*SCR*)) as responses to the *CS*.

Berger's preliminary study contained two conditions. In the first condition, observer was instructed that the model would receive shocks and react with an arm movement, whereas in the second condition instructions were that the model would react with a voluntary arm movement at a given signal of dimmed light, and that the

model was not receiving shock. Comparing the number of *SCR*, Berger showed that participants in the first condition gave more responses, meaning that conditioning was not solely depending on model's movement but the emotional response of the model was the determining factor.

As a follow up, Berger (1962) conducted a second study. In this study, a third control was added to the experimental design to determine whether the observers were affected only by the instructions concerning shock or that the presence of electricity in the shock generator had arousal effect independent of the model being shocked or not. The experiment contained four conditions, the first two being same as the previous experiment; in the third condition the model would receive shocks but wouldn't show arm movement, as a control for the instructions concerning shock. Fourth condition was included in order to assess the arousal effect of an electrified shock generator without shock to the model. In this condition, the model was told that no shocks would be delivered unless she touched the shock generator when the light dimmed, in which case she would be shocked. Although the differences were inconsistent, results were in the same direction with the first experiment, and provided further insights such as shock-movement interaction indicated that the effect of shock instructions depended on the model's arm movements and that presence of the electricity in the shock generator is not sufficient themselves.

A third experiment was conducted in order to refine measurement techniques and thus to improve reliability of differences; because it was thought that instructions and the reactions of the model might have resensitized the responses of the observer to the buzzer. Results of the third experiment, that observers in both conditions are

resensitized to the buzzer, suggest this resensitization may have tended to mitigate the reliability of the differences.

Considering results for all three experiments together, Berger provided one of the first physiological data of observational fear learning in humans; by showing that individuals who receive threat information and observe avoidance behavior of a model present greater *SCR*. Bandura and Rosenthal (1966) provided further evidence of observational transmission of conditioned emotional responses and revealed that observational conditioning is positively related to observers' emotional arousal level. These early studies on observational fear learning revealed strong evidence that physiological fear responses can be learnt, but provided only limited clues about the mechanisms of learning.

A series of animal studies also revealed strong evidence for observational learning of fear (e.g. Cook and Mineka, 1987, 1989, 1990; Mineka and Cook, 1986, 1993; Mineka, Davidson, Cook, and Keir, 1984). Following findings that laboratory reared rhesus monkeys do not display fear of snakes as the wild reared rhesus monkeys commonly exhibit (Mineka, Keir, and Price, 1980), indicating the fear of snakes is not innate in rhesus monkeys, Mineka et al. (1984) developed an experiment where 6 young rhesus monkeys observed adult models for 6 sessions, each consisting of 15 trials that lasted 40 seconds. Observers were pretested with the objects that were going to be used in the experiment and time spent with each stimulus was recorded. During the experiment, models and observers placed in adjacent cages with an acrylic glass in between so that observers can watch models but cannot touch them. Models interacted with neutral objects for 6 trials, also with real, toy and model snakes for 6 trials, and with neutral objects again for 3 trials in

each session. Observers were tested for acquisition of fear following sessions 2, 4 and 6 in a different cage than where the conditioning took place. Observers were given 5 minutes to freely enter or leave four compartments containing objects that the models have been interacting with. Five out of six observers showed rapid acquisition of fear, spending significantly less time in the real, toy and model snake compartments than they did in the pretest. A follow-up test was conducted after 3 months of the experiment, and the observers which acquired fear of snake showed no signs of loss of fear. The results of the study showed that rhesus monkeys acquire fear through observational learning and this acquisition is rapid, intense, long lasting and not context specific.

In another experiment with rhesus monkeys (Mineka and Cook, 1986) which observed nonfearful models interacting with snakes without showing any signs of fear, prior to observing fearful models; it was shown that latent inhibition phenomenon occurs in observational learning of fear. Second-order conditioning was also shown by an experiment (Cook and Mineka, 1987) where a striped box elicited fear response in observer rhesus monkeys when presented together with a snake.

In order to extend findings of adult and animal studies on observational learning and to provide insights on developmental fears; studies of observational learning in infants (e.g. Gerull and Rapee, 2002) and children (e.g. Askew and Field, 2007) were conducted. For instance, Gerull and Rapee investigated the effects of maternal modelling on the acquisition of fear (2002). The subjects were 30 infants modelled by their mothers. Mothers were taught to show positive or negative facial and vocal expressions as well as gesturing towards stimuli; a rubber snake and a

rubber spider, which were novel toys to the infants. In the experiment mother, infant and the concealed toy were positioned in a triangle. Mother captured the infant's attention, uncovered the toy and reacted with the previously assigned expression for a minute, covered the toy again and played with the infant for another minute. Then the mother captured the infant's attention, uncovered the toy again, but this time kept a neutral expression for a minute and finally covered the toy again. Afterwards, the mother and the infant would engage in an unrelated activity for a minute before going through the same procedure with the second toy. Experimental procedure was followed by a 10-minute free play session before the infant was presented with the toys in the initial order, while the mother kept a neutral expression. Researchers measured avoidance behavior of the infants when exposed to toys while mother kept neutral. Results revealed a clear effect of mothers' affective response on the infants' behavior and this effect was still present after a delay. Given that mothers showed emotional reactions for only the first 1-minute period and remained neutral afterwards, the persistence of avoidance behavior in infants indicate that they are not merely imitating their mothers, but learning actually took place.

Researches on infants and children showed that observational learning can result in persistent changes to fear cognitions and provide support to the idea that associative learning processes underlie observational learning (Askew and Field, 2008). Although results of past research on observational fear learning provide only limited information on the mechanisms; in recent years more studies have been conducted on the subject, especially the neural mechanisms of observational fear learning (e.g. Hooker, Verosky, Miyakawa, Knight, and D'Esposito, 2008; Olsson and Phelps, 2007).

1.3 Mechanisms of Observational Fear Learning

When Berger (1962) demonstrated that observers show greater skin conductance responses when they see the model's arm movements than in the other conditions, his findings revealed a vital component of observational fear learning; observer's interpretation of the model's emotional state. Another study that showed the importance of the interpretation of the model's emotional state was conducted by Kravetz (1974). Kravetz compared the heart rates of observers that were exposed to the heart beats of a model who was supposedly being shocked during a period of white noise which followed a tone. A control group was led to believe the noise was caused by a slide projector and told the model was performing a word task. None of the participants had visual clues. Results of the study showed that changes in the model's heart rate were sufficient to condition the changes in the observers' heart rate for the experimental group but not for the control group, providing further evidence on the importance of the observer's interpretation of the model's emotional state. Although these studies reveal the importance of the observer's interpretation of the model's emotional state; it was still possible that the model's *US* had a disproportionate influence on the observer compared to the model's response (Askew and Field, 2008). Hygge (1976; as cited in Askew and Field, 2008) conducted an experiment where model's *US* was completely neutral to the observer, ensuring it wouldn't have such influence on the observer. Observers were told that the neutral tone which followed a light was experienced as very painful by the model. Significant *SCR* were given by the observers to the light, indicating once again and with less ambiguity, observer's interpretation of the model's emotional state was crucial for observational learning of fear.

As mentioned before, animal studies also provided insights on the mechanisms of observational fear learning. Showing phenomena that detected in direct learning such as second-order conditioning and latent inhibition also in observational learning indicated that underlying mechanisms of both pathways to fear are similar (Cook and Mineka, 1987; Mineka and Cook, 1986). Mineka and Cook (1993) conducted another series of experiments with rhesus monkeys in order to test the hypothesis that mechanisms involved in observational and direct fear learning are similar; and concluded that observational fear learning might be mediated by both a cognitive social inference mechanism and the processes of direct conditioning.

Recent studies (Olsson and Phelps, 2004; Olsson, Nearing, and Phelps, 2007; Olsson and Phelps, 2007) introduce compelling evidence that underlying mechanisms of observational learning and direct learning of fear are similar. Olsson and Phelps (2004) compared three pathways to fear by examining whether participants show differential responses to masked *CS*s, which are followed by another stimulus that spatially overlaps immediately after presentation, and unmasked *CS*s, which were presented alone, depending on their learning experience; using *SCR* as a measurement of conditioned behavior. Results of the study revealed that all groups showed similar levels of learning to unmasked stimuli whereas only direct learning and observational learning groups showed significant learning response to masked stimuli; suggesting that underlying mechanisms of these types of learning might be similar.

Olsson, Nearing, and Phelps (2007) utilized functional magnetic resonance imaging (*fMRI*) to investigate whether the neural mechanisms of direct fear learning are similarly engaged in observational learning. Observers watched a movie displaying a model attending a differential fear conditioning experiment. Two different colored squares served as *CS* and were presented five times each, for 10s. CS^+ was paired with an electrical stimulation (*US*) while CS^- was never paired with a shock to the model. Observers were instructed to pay attention to which color is paired with the *US* while watching the movie, as they would attend the same procedure afterwards and receive shocks when presented with the same color of square. Results of the study revealed that role of amygdala in direct acquisition and expression of fear can be extended to observational learning of fear. Also, activation of anterior cingulate cortex and anterior insula suggest that empathic interpretations may play a role in observational fear learning. Finally, activation of anterior-rostral medial prefrontal cortex (*MPFC*), which is associated with self-knowledge, person knowledge and mentalizing (Amodio and Frith, 2006), provides neurological evidence to Berger (1962), Kravetz (1974), and Hygge's (as cited in Askew and Field, 2008) findings on the importance of the observer's interpretation of the model's emotional state and provides further support for role of empathy.

Hooker et al. (2008), showed the involvement of the amygdala-hippocampal complex in observational fear learning by collecting *fMRI* data of participants observing a model respond with fearful or neutral facial expressions to novel objects. It was found that after learning, the amygdala was active to the fear (vs. neutral) associated object when objects were presented alone. Results also revealed that

greater amygdala-hippocampal activity predicted better long-term memory for objects with a learned association.

Taking advantage of the knowledge base which has been cumulated since the Berger's studies on the mechanisms of observational fear learning, Olsson and Phelps (2007) proposed an amygdala-centered model. According to this model basic associative learning processes that modulate acquisition and expression of fear learning are similar across species and learning procedures, with contribution of social, affective and cognitive processes to observational fear learning. Amygdala has a functional role in fear learning. Lateral nucleus of amygdala (*LA*) is associated with synaptic plasticity that builds an association between representations of the *CS* and *US*; and projects to central nucleus (*CE*) and basal nucleus of amygdala (*B*), which mediates the output to other regions that regulate expression of fear. Hippocampus, which is a structure adjacent to the amygdala, is associated with encoding contextual information on various cues (details of the neural model of direct fear conditioning are shown in Figure 2).

Figure 2

Visual representation of the *CS* is formed in visual thalamus and visual cortex, while the somatosensory representation of the aversive *US* is formed in somatosensory thalamus and primary (*SI*) and secondary (*SII*) somatosensory cortex. These representations are sent to the *LA*, hippocampal memory system, anterior insula (*AI*), and anterior cingulate cortex (*ACC*) by thalamus and related sites of

sensory cortex. Input containing secondary representations of the *CS* and *US*, information about the learning context and the internal state of the organism is delivered to amygdala from hippocampal memory system, *AI* and *ACC*. Lateral nucleus of amygdala is where the sensory representations of the *CS* and *US* converge, therefore it is believed to be the site of learning. Association of visual representation of the *CS* and the somatosensory representation of the aversive *US* elicit direct fear conditioning. Projections of the *LA* to the *CE* are done directly and also indirectly through the basal nucleus of amygdala. Central nucleus of amygdala then regulates the autonomic output.

As mentioned before, it is suggested that underlying neural mechanisms of direct and observational fear learning are similar with a few exceptions (Figure 3). In the proposed neural model of observational fear learning, the visual representation of the *CS* is modified by its association with a *US* which is the perceived fear expression of a conspecific. Visual representations of both the *CS* and *US* are conveyed to *LA* through visual thalamus and visual cortex. Visual representations of the *US* are also projected to *MPFC, ACC, AI* and hippocampal memory system. The strength of the *US* may be modified by *MPFC* input related to the interpretation of the model's emotional state, which has been repeatedly proven crucial in observational learning, as well as cortical representations of empathic pain through the *ACC* and *AI* before the projection to *LA*. The output mechanism for observational fear conditioning is considered same as direct fear learning, regulated through central nucleus of amygdala.

Figure 3

If, as suggested, direct and observational learning operate on similar associative mechanisms in acquisition of fear; it is expected to demonstrate characteristics of classical conditioning also in observational learning. Therefore one of the most suitable paradigms to use for such demonstration would be blocking phenomenon; because blocking effect itself is an evidence of information processing in classical conditioning which means higher structures of the brain are also a part of Pavlovian learning.

1.4 Blocking Effect

Association between a novel *CS* and a *US* will not be learned if the *CS* is presented together with another *CS* that already predicts the *US*. This disruption in learning has been known as blocking effect and was first shown experimentally by Kamin (1968, 1969). When this phenomenon was first shown, it was a revolutionary development that changed our way of thinking about classical conditioning forever. Traditionally, classical conditioning has been seen as the acquired ability of a stimulus (conditioned stimulus) to elicit a response (conditioned response) which is originally evoked by another stimulus (unconditioned stimulus) as a result of temporal pairings (temporal contiguity) of the *CS* and the *US* (Rescorla, 1988).

Temporal contiguity has been widely studied, as it used to be considered the most prominent relation in Pavlovian conditioning (as cited in Domjan, 2005). The

role of temporal contiguity on associative learning has been investigated by varying the relative position of *CS* to *US*. Counterintuitively, perfect temporal contiguity (*CS* and *US* are presented simultaneously) did not effective enough to produce a strong *CS – US* association. In fact, a better evidence for conditioned responding was obtained when the *CS* is presented slightly before the *US*; such procedure is called delayed conditioning (see Domjan, 2005). Finally, conditioned responding was tested in a procedure characterized by a temporal gap between the presentations of the *CS* and the *US*, it is called trace conditioning. In trace conditioning, the strength of conditioned varied depending on the behavior system activated by the *US* in use (Figure 4).

Figure 4

Although temporal contiguity is an important factor in classical conditioning, the blocking effect demonstrated that contiguity is not sufficient to elicit conditioning per se, but the signal relations between stimuli are also crucial in associative learning. In blocking paradigm, association between a *CS* and a *US* will not be learned if the *CS* in question is presented in compound with another *CS* that already predicts the *US*; even when these compound stimuli and the *US* are presented in a delayed conditioning procedure (e.g. Eippert, Gamer, and Büchel, 2012), which is evidently the best temporal procedure that results in learning of *CS-US* associations. This effect occurs because conditioning is not governed only by the temporal contiguity, but also the informational relations of the stimuli (Rescorla, 1988). These informational

relations are referred to as the *CS-US* contingency. Importance of the *CS-US* contingency can be understood in consideration of a standard blocking procedure.

A standard blocking procedure contains an experimental group and a control group receiving a three-phase treatment. In the acquisition phase, experimental group receives a novel *CS* (A), paired with a *US* repeatedly, while the control group doesn't receive any conditioning treatment. In the blocking phase, another novel *CS* (X) is presented together with A to form a compound stimulus and the compound is paired with the *US* in both experimental and control groups. During the test phase, stimulus X is presented alone to both groups to see if it elicits a *CR* (Figure 5). Results of such designs show that there is a very little or no conditioned response to stimulus X, when it is presented alone in the test phase, in the experimental group and not the control group; meaning that the previously learned association between stimulus A and the *US* blocks the occurrence of a *CR* to the stimulus X, even though its temporal relation to the *US* is same as the temporal relation of the stimulus A and the *US*. According to this, for the experimental group which learns stimulus A predicts the *US*, newly added stimulus X doesn't contain new information about the US, therefore the potential effects of stimulus X is being blocked.

Figure 5

Probably, such an effect is not observed in the control group, because there is no previous experience and no known relation of the stimulus A and the US. This shows the importance of CS-US contingency in associative learning.

Blocking effect has been shown consistently in various animal species such as pigeons (Mackintosh and Honig, 1970), Japanese quail (Köksal, Domjan, and Weisman, 1994), rats (Illich, Salinas, and Grau, 1994) and rabbits (Kim, Krupa, and Thompson, 1998) at both behavioral and neural levels. For instance, while Kamin (1968, 1969) showed blocking using a conditioned suppression procedure; Mackintosh and Honig (1970) showed blocking effect by using an instrumental conditioning paradigm. Many of the early animal studies on blocking effect used food or shock as the *US*. Criticizing this, Köksal, Domjan, and Weisman (1994) showed blocking effect in sexual conditioning of Japanese quails. Kim, Krupa, and Thompson (1998) used eyeblink conditioning procedure, neural circuitry of which has been well established, on rabbits to describe neural mechanisms that mediate blocking. Results of the study showed that an input from inferior olive to the cerebellum, which is related to eyeblink conditioning, becomes suppressed as learning occurs during blocking and disruption of this suppression prevents blocking; suggesting that the inferior olive becomes functionally inhibited by the cerebellum during conditioning and that this negative feedback process might be the neural mechanism mediating blocking.

Unlike animal studies, studies conducted with human participants that investigate blocking have been inconsistent in their findings. Some studies successfully showed blocking effect (e.g. Arcediano, Matute, and Miller, 1997; Eippert et al., 2012, Hammerl, 1993; Hinchy, Lovibond, and Ter-Host, 1995) while others couldn't present such results (e.g. Davey and Singh, (as cited in Lovibond, Siddle, and Bond et al., 1988); Lovibond et al., 1988). Davey and Singh (as cited in Lovibond et al.,1988) found an outcome opposite to blocking; which according to

Lovibond et al. (1988) might be a result of measurement problems due to short *CS* duration. Lovibond et al. (1988) also failed to show reliable evidence of blocking in *SCR* measures, finding only a weak effect in one of four experiments and none in the rest. They suggested that these results may be caused by the usage of visual cues with semantic content and the method, in which the three phases of blocking were clearly divided from each other; therefore distracting participants' attention from the experimental contingencies.

Hinchy et al. (1995) designed an experiment integrating the three phases based on the aforementioned criticism. By adding extra trial types to the training phase, the distinction between the compound training and test phases was reduced. In order to prevent the effect of semantic content of the stimuli, simple colored squares were used as conditioned stimuli. The design for the experiment involved a training phase followed by a test phase for each of two groups; the blocking group and the overshadowing group which was serving as the control group. The two groups differed only in the training phase. The blocking group received the target stimulus C in compound with the stimulus A and the AC compound was paired with a shock which served as the *US*. The stimulus A was also reinforced alone and in compound with stimulus E. The stimulus B was included in the training which was never paired with another *CS* or the *US*. Stimulus F and compound stimulus GH were unreinforced trial types. Reinforced stimulus AE served to increase the validity of the stimulus A, whereas the two unreinforced stimuli F and GH reduced the density of reinforcement and ensured that not all compounds were reinforced.

The overshadowing control group received the same training as the blocking group, except that the target the target stimulus C was reinforced in compound with a novel stimulus D instead of the pre-trained stimulus A. The D cue received no other reinforced presentations. The control group also received the reinforced compound stimulus AE and unreinforced stimuli B, F and GH. Test phase was same for both groups, consisting of two trials each of a reinforced stimulus A and unreinforced stimuli C and B. Results of the study provided consistent evidences for blocking effect both in *SCR* and *US* expectancy measures.

Arcediano et al. (1997) examined blocking with human subjects using a conditioned suppression procedure which is similar to those commonly used in animal research. Previously discussed methodological problems were taken into consideration and the procedure was presented as a video game. In the experiment, participants first learned to press the space bar of a computer keyboard steadily followed by the two phases of standard blocking procedure. During the pre-training session, participants were instructed that the aim of the game was to prevent Martians from landing by using a laser gun, which was activated by pressing the space bar. Instructions of the first phase of blocking procedure told the participants to stop using the laser gun when the reflecting shield was activated, otherwise the Martians would successfully invade and that they would recognize activation of the reflecting shield when they saw a white flashing on the screen. This white flashing served as the *US*, as the participants need to suppress pressing the space bar when they see it. This phase also consisted of two conditioned stimuli; blue and yellow backgrounds (named stimulus A and stimulus B, counterbalanced). These were presented as indicators that would help predicting whether the shield is about to be

connected or not; and if they learn to distinguish between these indicators, they would always be able to avoid the shield. During the second phase the conditioned stimuli were presented in compound with two different tones (named stimulus X and stimulus Y, counterbalanced). The compound stimulus AX always terminated with the *US* while the compound stimulus BY was never paired with the *US*. In the test phase, stimulus X was presented once to all participants for 5 seconds. Results showed that a blocking effect analogous to that had been shown in animals can be obtained in humans; suggesting that previous problems in demonstrating blocking in humans were caused by methodological problems rather than of a fundamental nature.

Another effective method to blocking literature was introduced by Eippert et al. (2012) by using discriminative conditioning protocol. During the acquisition phase, participants were presented two arbitrary visual stimuli, the stimulus A which was terminated with a mild shock serving as the *US* and the stimulus B which was presented alone. Second phase was the blocking phase where the stimulus A was presented in compound with the stimulus X, and the stimulus B was presented in compound with the stimulus Y. Both compound stimuli were paired with the *US.* In order to prevent apparent distinction between phases, conditions from previous phases were intermixed with the new conditions and each phase started with the presentation of old conditions before new conditions were introduced. *US* expectancy ratings, *SCR*, heart rate and *fMRI* data were collected.

In order to show expression of blocking responses to the stimulus X and the stimulus Y were compared. Significantly stronger heart rate changes for the stimulus

Y than for the stimulus X was found, as well as higher expectancy ratings. *SCR* analysis did not reveal a significant difference, which was argued that might be due to the low level of responding at the late time point of the experiment.

Investigations of neurobiological mechanisms underlying the blocking effect revealed amygdala responses are significantly lower to the stimulus X than to the stimulus Y indicating that the blocking effect occurred; and that prefrontal regions play a significant role by flexibly changing their coupling to the amygdala. Analyses on the acquisition of blocking showed involvement of dorsolateral prefrontal cortex (*DLPFC*) by revealing significantly higher responses to the compound stimuli AX and BY than the stimuli A and B. This might be interpreted as relevant for the new learning during the acquisition of blocking; while the stimulus X is being established as not predictive for the *US*, the stimulus Y is being established as predictive. *DLPFC*-amygdala coupling was significantly negative on the compound stimulus AX; suggesting that establishing the stimulus X as redundant, in other words blocking, involves an active inhibitory process rather than occurring as a result of a passive process. This active process is probably a result of *DLPFC* mediated shaping of amygdala responses.

Eippert et al (2012) argue that when considered altogether, these results indicate that based on the requirements posed by predictive relationships, prefrontal regions flexibly change their coupling with the amygdala. Sensitivity of the amygdala responses to blocking effect show that these responses cannot be explain without referring to *CS-US* contingency. Considering importance of a mechanism

that modulates contingencies in a constantly changing environment; contributions of prefrontal regions to such a mechanism is undoubtedly advantageous.

Findings on neural mechanisms of blocking effect show that even though the center for fear learning is amygdala; projections from prefrontal cortex are also part of the mechanism. This information strongly supports the suggestion that underlying mechanisms of observational and direct fear learning are similar. Also, as mentioned before, it explains why we chose blocking effect to provide evidence for this suggestion.

As discussed by Olsson, and Phelps (2007), a better understanding of observational fear learning mechanisms is crucial, because social learning might be at the core of creation and maintenance of culture, which might then affect biological evolution. Hence, understanding these learning mechanisms would provide a bridge between the biological principles of learning and cultural evolution (Olsson, and Phelps, 2007). Also, considering that hallmarks of many psychological disorders such as phobias, which are characterized by dysfunctional assignment of emotional value to certain stimuli and situations, are socio-emotional impairments; it is important to provide knowledge about the underlying mechanisms of these impairments, which can be achieved through understanding social learning mechanisms. Here, we aim to provide further evidence and insights on similarity of the mechanisms of observationally and directly acquired fears. In this thesis blocking effect in observational fear learning was investigated by using a discriminative Pavlovian conditioning protocol. Following the method of Eippert et al. (2012), a *US*-predictive stimulus (CS^{+}_{A}) and a non-predictive stimulus (CS^{-}_{B}) were presented

in compound with two novel stimuli and both compound stimuli ([CS^{+}_{A} + CS^{+}_{X}], [CS^{-}_{B} + CS^{+}_{Y}]) were paired with a *US*. An additional control was included where a non-predictive stimulus (CS^{-}_{C}) was presented in compound with a novel stimulus and remained non-predictive ([CS^{-}_{C} + CS^{-}_{Z}]). Participants watched a video of a model engaging in an experiment using the mentioned paradigm. Afterwards, all stimuli were presented as single stimuli (CS_X, CS_Y, CS_Z, CS_A, CS_B, and CS_C) to the participants at the test phase of the experiment and no *US* were administered. Cognitive and autonomic responses given to stimuli during test phase were compared for determining whether blocking occurred. It is important to note that there are several manifestations of acquired fear. Behavioral responses that occur as a result of fear can be summarized as freezing, fleeing, fighting, submission, fright and faint (Buss, 2008). As well as measurement of behavioral results of fear acquisition, measurements of cognitive and autonomic responses are also commonly used in fear learning studies (e.g. Berger, 1962; Eippert et al., 2012). Therefore, in this study *US* expectancy levels were collected as cognitive responses, whereas skin conductance responses were collected as autonomic responses.

Our first hypothesis was that responses to CS_A would be higher than to CS_X, if blocking occurred during observational fear learning. We also expected higher responses to CS_Y than to CS_B, as the latter is doesn't predict the *US* by itself, the former would gain excitatory properties after the compound was paired with the *US*. Moreover, we expected no difference between responses to CS_C and to CS_Z, because they were never paired with the *US*.

CHAPTER 2: METHOD

In the present study, blocking effects in fear conditioning were investigated by using observational learning paradigm with human subjects in laboratory setting. In order to achieve this goal, a discriminative Pavlovian conditioning procedure has been used. The procedure consisted of acquisition phase, blocking phase and testing phase. During the acquisition and blocking phases, subjects watched video clips in which either a male or a female model had been recorded during the acquisition and blocking phases of a fear conditioning experiment. Typically, the fear acquisition procedure involved presentations of a CS^{+} and a CS^{-}, paired with and without an aversive *US*, respectively. In the blocking phase, additional *CSs* were added to the conditioned stimuli. Then, in the testing phase the subjects were tested by the conditioned stimuli in question.

For the acquisition phase of the videotaped experiment, three arbitrary conditioned stimuli were devised, namely CS^{+}_{A}, CS^{-}_{B}, and CS^{-}_{C}. CS^{+}_{A} was paired with a mild electrical stimulus which has served as the *US*, and CS^{-}_{B}, CS^{-}_{C} were

presented alone. During the blocking phase of the videotaped experiment, three novel stimuli were introduced in compound with previously conditioned stimuli ([CS^{+}_{A} + CS^{+}_{X}], [CS^{-}_{B} + CS^{+}_{Y}], [CS^{-}_{C} + CS^{-}_{Z}]).

A test phase was conducted after the video clip presentation. Testing variables were the six arbitrary stimuli which were also presented during the video (CS_X, CS_Y, CS_Z, CS_A, CS_B, and CS_C), all presented singly. Finally participants were expected to evaluate all the *CS*s on a 5-point Likert scale they were presented in terms of *US* expectancy. Skin conductance responses were also recorded throughout the experiment.

2.1 Participants

Initially, the study was planned to contain 40 participants. Convenience sampling method was used to recruit the participants, and they were provided with course credit. Participants were chosen using several elimination criteria related to their health status and prior experience with other fear conditioning studies. Anyone who met any one of these criteria was not included in the study. These can be summarized as;

- having any cardiovascular disease,
- having a history of any psychological/psychiatric disorder and being on medication related to this condition,
- having any medical treatment using mild electrical stimulation such as physical therapy,
- taking part in a prior study related to fear and anxiety,

Approximately 10% of the volunteers were eliminated due to meeting at least one of the criteria mentioned above. During data collection process, 96 participants attended the experiment. In the statistical analysis, valid data from 33 participants (27 female, 6 male) were used. Ages of the participants were between 18 and 27, with a mean of 22.00 (*SD* = 5.07).

The rate of attrition a depended on the further elimination criteria which were set based on the performance of the participants. These were:

- not completing the experiment (dropout),
- not following the instructions properly,
- not showing any *SCR* to testing stimuli.
- not meeting the criteria related to acquisition of fear (see preparation of data for analysis).

If any of these were observed during the experiment or analysis, data in question were excluded. Approximately 47% of the participants' data were discarded due to dropouts, not following instructions or irresponsiveness. 14% of the data were eliminated due to not meeting the acquisition criteria. This amount of data loss is attributed to the nature of the experiments which contain several stages. Finally, %1 was discarded due to extreme values in the distribution. Ethical guidance of Turkish Psychological Association was followed during participant recruitment process, as well as throughout each session.

2.2 Stimuli, Apparatus, and Material

2.2.1 Stimuli

Videos of recreated experimental sessions were used in acquisition phase. Stimuli that were used as *CS*s in the videos were geometrical shapes obtained from Microsoft Word font sets (Figure 6). Fonts and character codes are as follows; CS_X, Wingdings 2, 248; CS_Y, Wingdings, 178; CS_Z, Wingdings, 163; CS_A, Wingdings, 122; CS_B, Arial, 042E; and CS_C, Wingdings, 118.

Figure 6

Mild electrical stimulus was used as *US*. Electrical stimulation was applied through disposable Ag/AgCl electrodes with wet gel (Model: E5 T815W, Bio Protech Inc.) with a pulse stimulator box (Model: STMISOLA, BIOPAC Systems. Inc.).

The same arbitrary stimuli as in the videos were presented in the test phase. Electrical stimulation was administered through carbon film electrodes (Model: EERC200M, BioMedical Life Systems, Inc.) with a pulse stimulator box (Model: SD9, Grass Technologies). The electrodes were fastened with a cloth bandage.

2.2.2 Participant Evaluation and Informed Consent Forms

Informed Consent Form was given to the participants before the experimental session (Appendix A). The form consists of information about the aim and the procedure of the study, as well as explanation of participants' rights.

Participant Evaluation Form was developed by academic staff of Psychology Laboratory in Izmir University of Economics for a previous study on fear learning and has been used as a standard form for all fear related studies conducted in this laboratory since then (Appendix B). The form contains questions about both past and current physiological and psychological well-being (e.g. Were you diagnosed with any phobic disorder? Are you on medication for any particular health problem?), and also questions to discover previous experiences on any research participation (e. g. Did you participate in any other experiment in past 12 months?). The form was given to all recruited participants before the experimental session, in order to see whether they are able to satisfy the participation criteria of the study.

2.2.3 Stimulus Presentation Programs

Three different stimulus presentation programs were prepared using a psychological experiment generator (SuperLab™, Model: 4.5; Cedrus Corporation). First program was prepared for presenting stimuli to the models. Two other programs were prepared for presenting the videos and testing stimuli. Each video consisted of the same experimental sessions with either a male or a female participant. Videos were edited using Windows Movie Maker (Microsoft Corporation).

Stimulus presentation programs were run on a personal computer (AMD FX (TM) 6100 six core processor, 3.30 GHz, 4 GB of RAM) connected a 22″ stimulus presentation monitor with a screen resolution of 1600*900 pixels, and refresh rate of 60 Hz during video recordings; while a personal computer (AMD FX (TM) 6100 six core processor, 3.30 GHz, 4 GB of RAM) connected a 20″ stimulus presentation monitor with a screen resolution of 1600*900 pixels, and refresh rate of 60 Hz was used during experimental sessions.

2.2.3.1 In-video Program

Two versions of the same video of an experimental session were recorded. These videos consisted of a male or a female model attending an experiment where a discriminative Pavlovian conditioning paradigm for investigation of blocking effect in fear conditioning is used. Each video started with preparation of the model and instructions, followed by beginning of a countdown which was skipped with a fade out effect. After the countdown ended, with a fade in, the models were given on-screen instructions followed by presentations of 6 CS^{+}_{A}, 6 CS^{-}_{B}, and 6 CS^{-}_{C} randomly, each lasting 4000ms. CS^{+}_{A} always ended with a *US* that was presented during the last 200ms of CS^{+}_{A} presentation. CS^{-}_{B}, and CS^{-}_{C} were never paired with a *US*. In order to mask the transition between acquisition and blocking phases, blocking phase was divided into two sections as early and late blocking phases.

Early blocking phase came after the acquisition phase and consisted of single stimuli and compound stimuli, presented randomly. In this phase CS^{+}_{A} was combined with a CS^{+}_{X} ([CS^{+}_{A} + CS^{+}_{X}]), CS^{-}_{B} was combined with a CS^{+}_{Y} ([CS^{-}_{B} + CS^{+}_{Y}]), and CS^{-}_{C} was combined with a CS^{-}_{Z} ([CS^{-}_{C} + CS^{-}_{Z}]). Each compound stimulus was presented 3 times and each presentation lasted 4000ms. [CS^{+}_{A} + CS^{+}_{X}] and [CS^{-}_{B} + CS^{+}_{Y}] ended with a *US* that was presented during the last 200ms. Single stimuli in early blocking phase consisted of 2 CS^{+}_{A}s, 2 CS^{-}_{B}s, and 2 CS^{-}_{C}s, each lasted 4000ms. Only CS^{+}_{A}s ended with a *US* during the last 200ms presentation.

Late blocking phase consisted of only compound stimuli of [CS^{+}_{A} + CS^{+}_{X}], [CS^{-}_{B} + CS^{+}_{Y}], and [CS^{-}_{C} + CS^{-}_{Z}]. Each compound stimulus was presented 3 times and each presentation lasted 4000ms. [CS^{+}_{A} + CS^{+}_{X}] and [CS^{-}_{B} + CS^{+}_{Y}] ended with a *US* that was presented during the last 200ms. Inter-trial interval was 10s between the

stimulus presentations. Although it is described as different phases and sections; all the stimuli were presented without any disruptions, as it has been shown repeatedly (Arcediano et al., 1997; Hinchy et al., 1995; Lovibond et al., 1988), smoothness of the transitions among the phases is a critical feature of methodology in blocking studies.

Each stimulus appearance was marked with a white dot on the lower right corner of the video. This change was detected by a photocell during the experimental sessions (see the section "Data Acquisition System"). The photocell was concealed under a black foam material to make it less noticeable.

2.2.3.2 Experimental Program

All sessions began with a five-minute habituation/ relaxation phase before the presentation of the video. In the first two minutes of this phase participants were given instructions and expected to adapt to the laboratory environment. During the next three minute-period participants were shown a countdown where they could relax and see when the experiment is going to start. Following the countdown, participants were presented with a video of an experimental session. The video presentation was followed by the test phase where participants were presented with the same stimuli as presented to the model. Each stimulus (CS^{+}_{X}, CS^{+}_{Y}, CS^{-}_{Z}, CS^{+}_{A}, CS^{-}_{B}, and CS^{-}_{C}) was presented for 4000ms with an inter-trial interval of 10s while recording *SCR*. None of the stimuli were paired with a *US*. After test phase, *US* expectancy scores were recorded on a 5-point Likert scale (1: Did not expect to receive shock at all, 5: Definitely expected to receive shock) by showing the stimuli again.

2.2.4 Data Acquisition System

Skin conductance responses during the experimental sessions were collected through MP150WSW-G Data Acquisition System which was connected to two Ag-AgCl finger electrodes (Model: SS3LA, BIOPAC Systems, Inc.) via a Galvanic Skin Response amplifier GSR100C (BIOPAC Systems, Inc.). Piece of transmission gel (Wicromed Gel®) was applied at the contact points of the electrodes in order to minimize noise interference and improve recordings.

In order to track stimulus presentations in the video, each stimulus appearance was marked on the video. These changes were detected by a photocell connected to StimTracker™ (Cedrus Corporation), which sent information to the data acquisition system through a general purpose transducer amplifier DA100C (BIOPAC Systems, Inc.).

AcqKnowledge™ (Model: 4.2; BIOPAC Systems, Inc.) software recorded the data and was used for offline analyses. Data recording software was run in another computer (AMD FX (TM) 6100 six core processor, 3.30 GHz, 4 GB of RAM) connected a 20″ stimulus presentation monitor with a screen resolution of 1600*900 pixels, and refresh rate of 60 Hz; which was placed in a control room adjacent to the experimental room, in order to be able to monitor measurements in real-time. The *US* expectancy scores during test phase was recorded by and obtained from the data output of SuperLab™ program.

2.3 Experimental Procedures

2.3.1 In-video Procedure

The video presentation consists of a model attending an experimental session where a discriminative Pavlovian conditioning paradigm for investigation of blocking effect in fear conditioning is conducted. Before stimuli are presented, participant is taken in the experimental room and prepared for the experiment. Preparations began with cleaning the electrode sites by applying alcohol on a piece of cotton pad. This procedure was followed by placing *SCR* electrodes on the right hand palm and placing electrical stimulation electrode on the left wrist of the participants; which was closer to camera, allowing participants to see possible hand movements of the models when the electrical *US* applied (Figure 7).

Figure 7

After the placement of all the electrodes, models determined the level of electrical stimulation themselves while assisted by the experimenter. Experimenter set the shock at 10V and delivered a test stimulation manually and gradually increased or decreased to the level until it was declared “uncomfortable but not painful” by the participant.

Models were instructed to not move their right hands during the session and use their left hands when needed in order to keep the *SCR* measurements unaffected from the movements. These instructions were given in order to increase the

credibility of the video. They were also instructed to place their heads on the chinrest. This was necessary in order to make sure they were sitting still during the recordings. After all instructions are given, researcher left the experimental room. Models started the experiment by pressing a button on the keyboard when they were ready.

The in-video-experiment program consists of acquisition phase with 6 CS^{+}_{A}, 6 CS^{-}_{B}, and 6 CS^{-}_{C} presented randomly, followed by an early blocking phase consisting of 9 compound stimuli (3 [CS^{+}_{A} + CS^{+}_{X}], 3 [CS^{-}_{B} + CS^{+}_{Y}], and [CS^{-}_{C} + CS^{-}_{Z}]) and 6 single stimuli (2 CS^{+}_{A}, 2 CS^{-}_{B}, and 2 CS^{-}_{C}). Late blocking phase consists of 9 compound stimuli (3 [CS^{+}_{A} + CS^{+}_{X}], 3 [CS^{-}_{B} + CS^{+}_{Y}], and 3 [CS^{-}_{C} + CS^{-}_{Z}]). All stimuli were presented randomly, each lasting 4000ms. CS^{+}_{A}, [CS^{+}_{A} + CS^{+}_{X}], and [CS^{-}_{B} + CS^{+}_{Y}] were paired with a 200ms *US* while the rest of the stimuli were not paired with the *US*. Inter-trial interval lasted 10s between the stimulus presentations. A flowchart of the in-video experiment can be seen on Figure 8.

Figure 8

2.3.2 Experimental Procedure

Experiments were conducted in a soundproof experimental room and controlled from another soundproof control room next door (Figure 9). Stimuli were presented on the computer in the experimental room which also sent signals to the control computer in the control room. Computer in the control room was used for both live feed of the data and recording of it. Experimental room was recorded with a video camera during all sessions.

Figure 9

Before the experimental sessions begin, participants were informed about the experiment and given an Informed Consent Form (Appendix A) to fill out, followed by a Participant Evaluation Form (Appendix B). Participants who were eligible to attend the experiment were given a participant number after these procedures.

After filling out forms, participants were taken to the experimental room and prepared for the session. Preparations began with cleaning the electrode sites by applying alcohol on a piece of cotton pad. This procedure was followed by placing *SCR* electrodes on the first and third digits of the left hand and placing electrical stimulation electrodes on the right wrist of the participants (Figure 10). Placing the stimulation electrodes served the aim of being realistic although stimulation is never used during the experiment.

Figure 10

After the placement of all the electrodes, participants determined the level of electrical stimulation themselves while assisted by the experimenter. Experimenter set the shock at 10V and delivered a test trial manually and gradually increased or decreased the level until it was declared “uncomfortable but not painful” by the

participant. Maximum shock level was set at 60V as in the previous studies using electrical stimulation with human participants (e.g. Schiller et al., 2010).

Participants were instructed to not move their left hand during the session and use their right hand when needed in order to keep the *SCR* measurements unaffected from movements. Rest of the instructions was as follows:

> "When the experiment begins you will first watch a countdown video. Please try to relax during this period. When the countdown ends, you will watch a video of another participant attending a very similar experiment as the one you are attending now. During that experiment, the participant will be presented with some geometrical shapes. S/he will receive a mild electrical stimulus with some of these shapes. You need to learn which shapes are paired with the shock and which aren't. It is very important that you watch the video carefully, because when the video ends and your experiment begins, you will receive electrical stimulus with the same shapes as in the video. The shapes that were not paired with the shock in the video will also be presented without shock to you. Your experiment will last much shorter, as you will see every shape only once. You will receive shock at least one time and at most three times".

After all instructions were given, researchers left the experimental room. Participants started the experiment by pressing a button on the keyboard when they were ready.

Experiment program began with a habituation period to make sure participants could adapt to the experimental environment and relax. This period was

followed by the video including a model attending acquisition and blocking phases described before. The program continued with the test phase where participants were presented with the single version of the *CS*s they saw in the video (Figure 11). This phase was followed by *US* expectancy questions; where all single stimuli were shown once more, with a 5-point Likert scale placed underneath. Participants were asked to evaluate how much they expected receiving shock with the presented *CS* by clicking the appropriate number on the computer keyboard.

Figure 11

2.4 Preparation of Skin Conductance Data for Analysis

Skin conductance responses were obtained through MP systems and recorded by using AcqKnowledge™ 4.2, as mentioned before. Two channels were used during data acquisition (Figure 12); one for recording *SCR* of participants during the experimental session and the other for recording the time periods of stimulus delivery through a photocell by the StimTracker™.

Figure 12

In order to measure individual skin conductance response to the specific stimulus, the response was measured from base to peak, and the difference in between was calculated, which is the amplitude of the response in microsiemens (μs).

For a waveform in skin conductance data to be considered as a response to the corresponding stimulus, the base of the waveform must be within the 500ms to 5000ms time interval following the onset of stimulus (Figure 13) and must have an amplitude value greater than 0.02μs which was minimum *SCR* criterion as used in previous fear conditioning studies (e.g. Olsson et al. 2007; Schiller et al., 2010).

Figure 13

Before the main analyses of the data to test the hypotheses, acquisition scores of the participants were calculated to make sure that participants had acquired the fear during acquisition, in other words that these data were valid for using in the main analyses.

2.4.1 Calculation of Acquisition Score

Acquisition score was calculated for each participant from *SCR* given to all CS^{+}_{A}, CS^{-}_{B}, and CS^{-}_{C} presentations in acquisition stage. For each trial, the amplitude of the response corresponding to that trial was calculated as described above. All 18 amplitude values were transformed by using the square-root transformation; as it is suggested that usually distributions of *SCR* are negatively skewed (Boucsein, 2012). These normalized scores were scaled according to each participant's response to the *US*, which is the first time they see the model receiving an electrical stimulus; by dividing each response by the square-root transformed unconditioned response.

Difference scores were calculated between scaled CS^{+}_{A} and CS^{-}_{B}; and CS^{+}_{A} and CS^{-}_{C} responses. Finally, by averaging these difference scores, acquisition score

was obtained (Figure 14). In order to decide whether participants had acquired fear or not, criterion proposed by Schiller et al. (2010) was used. According to this, participants who had acquisition scores "larger than 0.10" regarded as developed conditioned responses to CS^{+}_{A}. Anyone who failed to meet this criterion were considered as invalid data and excluded from further analysis.

Figure 14

Following the calculations of acquisition scores, *SCR* to test stimuli of the participants who met acquisition criterion were calculated. Amplitudes of the responses to testing stimuli were calculated and scaled according to each participant's response to the *US*. These weighted scores were used for testing the main hypotheses of the study.

2.5 Statistical Analyses

Before testing the hypotheses, a preliminary examination of the data was performed by exploring dependent measures regarding distribution of the data. Consequently, extreme values were excluded from the analysis by using *z*-scores as suggested by Field (2009). According to this, all dependent measures were converted to *z*-score and then *z*-scores with absolute value greater than 3.29 were detected as extreme values and deleted from the data. In total, 5 participants with extreme scores were excluded. Outlier scores were detected by checking boxplots and as a result mean imputation was performed for a total of 8 outlier scores of 6 participants. In order to test whether blocking can be observed on *SCR* measures, paired *t*-tests were

conducted and significance levels were corrected by using Bonferroni correction. For determining blocking effect on *US* expectancy, Wilcoxon signed-rank test was conducted as the variables were not normally distributed and significance levels were corrected by using Bonferroni correction.

CHAPTER 3: RESULTS

3.1 Procedural Analyses

A procedural control was performed on *SCR* recorded in the first two stages of the study in order to make sure that employed differential fear learning paradigm worked throughout the acquisition and blocking stages.

3.1.1 Acquisition Stage

In order to perform a procedural control on the acquisition stage, a 3 (type of stimulus) x 6 (trial number) factorial repeated measures ANOVA was conducted. There was a significant main effect of the type of stimulus on the *SCR*, $F_{(2, 52)} = 42.46$, $p < .05$, $\eta^2 = .62$. Contrasts revealed that *SCR* for both CS^-_B, $F_{(1, 26)} = 54.09$, $p < .05$, $\eta^2 = .68$; and CS^-_C, $F_{(1, 26)} = 69.15$, $p < .05$, $\eta^2 = .73$ were significantly lower than CS^+_A.

There was also a significant main effect of the trials on the *SCR*, $F_{(5, 130)} = 10.82$, $p < .05$, $\eta^2 = .29$. A linear contrast revealed that as the trials proceed, skin conductance responses significantly change, $F_{(1, 26)} = 43.51$, $p < .05$, $\eta^2 = .63$.

Mauchly's test indicated that the assumption of sphericity had been violated for the interaction effect between the type of stimulus and the trial number, $\chi^2_{(54)} = 99.51$, $p < .05$. Therefore degrees of freedom were corrected using the Greenhouse-Geisser estimates of sphericity ($\varepsilon = .57$). Interaction effect was found significant, $F_{(5.72, 148.64)} = 3.09$, $p < .05$, $\eta^2 = .11$ (Figure 15).

Figure 15

As a follow up for the interaction effect, one-way repeated measures ANOVA was conducted for each trial. As there were 6 trials, we adjusted the significance levels by using Bonferroni correction. For the first trial, results showed a significant difference in *SCR* between the stimuli, $F_{(2, 62)} = 14.22$, $p < .008$, $\eta^2 = .31$. Contrasts revealed that *SCR* for both CS^-_B ($M = .34$, $SD = .36$), $F_{(1, 31)} = 9.97$, $p < .05$, $\eta^2 = .24$; and CS^-_C ($M = .22$, $SD = .29$), $F_{(1, 31)} = 28.14$, $p < .05$, $\eta^2 = .48$ were significantly lower than CS^+_A ($M = .56$, $SD = .33$). For the second trial, results showed a significant difference in *SCR* between the stimuli, $F_{(2, 60)} = 11.34$, $p < .008$, $\eta^2 = .24$. Contrasts revealed that *SCR* for CS^+_A ($M = .45$, $SD = .30$), did not differ from CS^-_B ($M = .38$, $SD = .31$), $F_{(1, 30)} = 1.00$, $p > .05$; while it was significantly higher from CS^-_C ($M = .14$, $SD = .27$), $F_{(1, 30)} = 25.08$, $p < .05$, $\eta^2 = .46$. For the third trial, results showed a significant difference in *SCR* between the stimuli, $F_{(2, 62)} = 7.54$, $p < .008$, $\eta^2 = .20$. Contrasts revealed that *SCR* for both CS^-_B ($M = .18$, $SD = .23$), $F_{(1, 31)} = 11.99$, $p < .05$, $\eta^2 = .28$; and CS^-_C ($M = .17$, $SD = .27$), $F_{(1, 31)} = 8.28$, $p < .05$, $\eta^2 = .21$ were significantly lower than CS^+_A ($M = .42$, $SD = .37$). For the fourth trial, results

showed a significant difference in *SCR* between the stimuli, $F_{(2, 60)} = 8.13$, $p < .008$, $\eta^2 = .21$. Contrasts revealed that *SCR* for both CS^-_B ($M = .14$, $SD = .26$), $F_{(1, 30)} = 8.77$, $p < .05$, $\eta^2 = .23$; and CS^-_C ($M = .13$, $SD = .22$), $F_{(1, 30)} = 16.90$, $p < .05$, $\eta^2 = .36$ were significantly lower than CS^+_A ($M = .35$, $SD = .25$). For the fifth trial, Mauchly's test indicated that the assumption of sphericity had been violated, $\chi^2_{(2)} = 18.06$, $p < .05$; therefore degrees of freedom were corrected using the Greenhouse-Geisser estimates of sphericity ($\varepsilon = .69$). The results showed a significant difference in *SCR* between the stimuli, $F_{(1.38, 42.69)} = 16.31$, $p < .008$, $\eta^2 = .35$. Contrasts revealed that *SCR* for both CS^-_B ($M = .05$, $SD = .13$), $F_{(1, 31)} = 27.12$, $p < .05$, $\eta^2 = .47$; and CS^-_C ($M = .15$, $SD = .24$), $F_{(1, 31)} = 9.90$, $p < .05$, $\eta^2 = .24$ were significantly lower than CS^+_A ($M = .37$, $SD = .36$). Finally, for the sixth trial, results showed no significant difference in *SCR* between the stimuli, $F_{(2, 58)} = 3.85$, $p > .008$.

3.1.2 Blocking Stage

In order to perform a procedural control on the blocking stage, a 3 (type of stimulus) x 6 (trial number) factorial repeated measures ANOVA was conducted. Results revealed no significant main effect of type of stimulus on *SCR*, $F_{(2, 48)} = .73$, $p > .05$. Mauchly's test indicated that the assumption of sphericity had been violated for the main effect of trial number, $\chi^2_{(14)} = 28.55$, $p < .05$; therefore degrees of freedom were corrected using the Greenhouse-Geisser estimates of sphericity ($\varepsilon = .66$). The results showed that there is no significant main effect of trial number on *SCR*, $F_{(3.32, 79.70)} = .73$, $p > .05$. Mauchly's test indicated that the assumption of sphericity had been violated for the interaction effect between the type of stimulus and the trial number, $\chi^2_{(54)} = 85.73$, $p < .05$. Therefore degrees of freedom were

corrected using the Greenhouse-Geisser estimates of sphericity (ε = .59). Interaction effect was found not significant, $F_{(5.91, 141.84)} = 2.09$, $p > .05$, (Figure 16).

Figure 16

3.2 Hypothesis Testing

3.2.1 Skin Conductance Data

In order to show blocking effect on skin conductance data, three comparisons were needed. In an attempt to control familywise error; we chose using paired t-tests instead of one-way repeated measures ANOVA, where we would have received comparisons that were unrelated to our hypotheses. As there were three comparisons, significance level was adjusted using Bonferroni correction. Results revealed that responses given to CS_A (M = 1.04, SE = .07) and to CS_X (M = .97, SE = .04) did not differ, $t_{(32)} = -1.13$, $p > .017$. It was also shown that responses given to CS_Y (M = .71, SE = .07) were greater than to CS_B (M = .45, SE = .08), $t_{(32)} = 2.90$, $p > .017$, r = .46. Finally it was revealed that there was no significant difference between the responses given to CS_C (M = .21, SE = .05) and to CS_Z (M = .33, SE = .05), $t_{(32)} = 1.74$, $p > .017$ (Figure 17).

Figure 17

3.1.2 US Expectancy

Distribution of the *US* expectancy levels were not normal; therefore in order to show blocking by comparing *US* expectancy levels depending on the testing stimuli, Wilcoxon singed-rank tests were used as a nonparametric counterpart of paired t-test. Again, this analysis was chosen in order to control familywise error by using only the comparisons related to our hypotheses. As there were three comparisons, significance level was adjusted using Bonferroni correction. Results revealed that *US* expectancy levels for CS_A (*Mdn* = 5.00) were significantly higher than for CS_X (*Mdn* = 2.00), $z = -4.17$, $p < .017$, $r = -.51$. Also, *US* expectancy levels for CS_Y (*Mdn* = 2.00) were significantly higher than for CS_B (*Mdn* = 1.00), $z = -2.55$, $p < .017$, $r = -.31$. No significant difference between *US* expectancy levels for CS_C (*Mdn* = 1.00) and *US* expectancy levels for CS_Z (*Mdn* = 1.00) were observed, $z = -1.99$, $p > .017$ (Figure 18).

Figure 18

CHAPTER 4: DISCUSSION

There is accumulating evidence implying that underlying mechanisms of direct and observational fear conditioning are similar. As mentioned in previous sections of this thesis, these similarities have been discussed at conceptual level as well as behavioral and neurobiological levels. Here, we aimed to provide further evidence to the literature on these similarities with a fresh point of view in an unexplored area.

Our main assumption was that if as suggested, direct and observational fear learning engage in similar associative mechanisms in fear acquisition; we should be able to demonstrate characteristics of classical fear conditioning also in observational fear learning. In order to do so, blocking phenomenon was chosen due to its historical significance. As explained before, demonstration of blocking effect changed our way of thinking about classical conditioning profoundly by showing information processing is a part of classical conditioning and that higher functions of the brain are also involved.

In order to test the assumption that blocking effect can be demonstrated in an observational fear learning setting; models were exposed to a blocking procedure where the stimulus control was provided through a discriminative Pavlovian conditioning paradigm. The *CS-US* pairings were arranged in a delayed conditioning procedure, where the *US* were administered 200ms before the end of *CS* presentations. These sessions were recorded and participants got to observe the models in the videos during the experimental sessions.

The method used in this study is important for being the first in this area because blocking has never been studied in observational learning of fear. Although blocking in observational fear learning has never been studied, there is one study that has to be mentioned, which was conducted by Galef and Durlach (1993), for being the only research investigating blocking in an observational setting. Although they have failed to show blocking and overshadowing in appetitive learning, their follow up experiment showed overshadowing in aversive conditioning. Unfortunately, they did not use blocking in the follow up experiment; therefore it remained unclear whether blocking could have been observed in an aversive conditioning in an observational setting. They also argued that the failure might have been due to issues of temporal relations. They reported that *CS* and *US* were presented to observers simultaneously during the appetitive conditioning procedure while the presentations were made sequentially during the aversive conditioning procedure, where they successfully showed an effect that failed before.

Another methodological contribution to literature made by this research is that usage of distractor and control stimuli at the same time. Literature on blocking

contains studies which used overshadowing in a between groups design as a control mechanism (e.g. Hinchy et al., 1995). The studies which used within subject designs used only control stimuli (e.g. Arcediano et al., 1997) or only distractor stimuli (e.g. Eippert et al., 2012). Therefore, combining distractor and control stimuli in a within subjects design is a novel method developed and conducted in this study.

In order to test the effectiveness of the method used, prior to hypothesis testing, we administered procedural analyses. During the observation phase, only measure collected was *SCR*; therefore, we compared these responses for each of the stimuli and the trial number of the stimuli presented during acquisition and blocking stages, which are the stages that constitute the observation phase. Our results revealed that during acquisition stage, the responses to the CS^+ were significantly higher than the responses to both of the CS^-, for the first trial. We detected that this is a result of stimulus order in the videos. Even though the programs were run with a randomization input, by chance both videos started with the CS^+. Stimulus sequence was not edited in videos for randomized presentation for each participant even though the stimuli were presented randomly for each model, therefore it is believed that this resulted in higher responses towards the first stimulus. For the second trial the results were contradicting, which was not unforeseen, as in such an early stage occurrence of learning is not expected. In the third, fourth and fifth trials results indicated a clear learning pattern, as in all these trials responses towards the CS^+ were significantly higher than the responses to both of the CS^-. Finally, there were no differences detected in the sixth trial, which is believed to be a result of habituation, considering the responses get smaller in amplitude over the trials.

These results made it clear that our participants acquired conditioned fear responses by watching the models. Unfortunately, we failed to detect any differences during the blocking stage. Although we hypothesized that we would be able to see differences between stimuli which were paired with the *US* and the stimuli which weren't; the results obtained were not completely unexpected. Eippert et al. (2012), reported failure on detecting significant differences in *SCR* during the blocking stage and argued that this was due to lack of responding at the late stage of the experiment while reporting that their participants responded only to 34% of the trials. Considering that our participants only responded to 29% of the stimuli at this stage, the results are far from shocking. We suggest shorter experimental procedures might give better results. Overall, our results showed that the paradigm used in this study worked properly, which is also supported by the results of the comparisons of control and distractor stimuli during test phase that will be discussed below.

As mentioned before, in the test phase of this study, participants were presented with the single versions of the stimuli which have been added to compound stimuli in the second stage (CS_X, CS_Y, CS_Z), and the stimuli that were also presented during acquisition stage (CS_A, CS_B, CS_C). As in a standard blocking procedure, in order to show blocking we compared each of the previously presented with their add-on stimuli. The pair of CS_A and CS_X were our main stimuli, where we aimed to show blocking while the pair of CS_C and CS_Z were our control pair. Finally, CS_B and CS_Y were paired in a fashion that is opposite of blocking and used as distractor.

The analysis on *SCR* revealed unexpected yet interesting results. First of all, our control comparison of CS_C and CS_Z yielded no significant difference, indicating

that our differential paradigm worked as expected. Furthermore, the comparison of distractor stimuli CS_B and CS_Y showed the responses were higher towards CS_Y than towards CS_B. Keeping in mind that CS_B was not signaling the *US* in the acquisition phase, which is also supported by our preliminary procedure analyses; and that the compound stimulus where CS_Y was added next to CS_B was paired with the *US* during blocking phase; higher responses towards the former is an expected result. This provides further evidence to effectiveness of our paradigm.

The result on our main hypothesis was not supported though. We hypothesized that if blocking occurred we would see greater responses to CS_A than to CS_X, but that was not the case. This could have meant that blocking cannot be shown in an observational fear learning setting. However, considering our results on *US* expectancy levels, we know that this is not the case. Before discussing this finding further, it is important to take a look at the results on *US* expectancy levels.

The results on *US* expectancy levels on the comparisons for the pair of CS_B and CS_Y and the pair of CS_C and CS_Z revealed results in the same direction as *SCR*, which supported our interpretation on the effectiveness of our procedure. Our main hypothesis about CS_A and CS_X, that the responses would be greater towards CS_A than towards CS_X was confirmed. This result falsifies the interpretation that blocking cannot be observed during observational fear learning that is provided by the results of the analysis on skin conductance responses.

Here, it is necessary to address the contradiction of the results of physiological and cognitive measurements. We believe that this is an outcome of the phenomena we use in this study. Both observational fear learning (Olsson, and

Phelps, 2007) and blocking effect (Eippert et al., 2012) are characterized with involvement of the prefrontal cortex and higher cognitive functions. As a result of this involvement, it is not surprising that we can obtain cognitive evidence on blocking in observational fear learning. The reason why we were not able to obtain similar results in our physiological data might depend on the unambiguity of contingencies. As Schultz and Helmstetter (2010) claimed, according to dual process theories conditioning can occur on an implicit level without explicit knowledge about the contingencies. This might also be true vice versa. As discussed in previous sections; we know that blocking effect occurs as a result of the role of *CS-US* contingency in conditioning. If as the dual process theories interpreted, implicit and explicit levels of conditioning differ from each other; this might be the reason why we cannot see blocking effect on autonomic level, which was measured by *SCR*; while we can on cognitive level, which was measured by *US* expectancy. To be more clear, during a blocking procedure, the *CS-US* contingency is explicit to the participants. Keeping in mind that our participants were instructed that they needed to keep an eye on the stimuli, which were presented to the models, because they would receive shock with the same shapes as the models did, it is possible that our participants directed their attention towards the contingencies. This might have made the contingencies more unambiguous during an observational fear learning paradigm. This explicit knowledge of the contingencies may have obstructed learning on the implicit level; while learning on the explicit level occurs. This is a very important hypothesis which needs to be tested again in order to provide a further understanding of the mechanisms of observational fear learning.

Overall results show evidence for blocking in observational fear learning but, nonetheless, few adjustments to the methodology can improve the shortcomings of this study. The biggest issue detected was how long the observation phase lasted. Many participants expressed this as a negative comment. Although the discriminative Pavlovian paradigm required the amount of stimuli presented, we believe that it was possible to shorten the inter-trial intervals and maybe even the number of each stimuli is presented; considering single stimulus learning has been included in effective observational learning procedures by Heyes (1994). It is believed that this might lessen dropouts and irresponsiveness during the blocking and test phases, thus prevent loss of participants, which was a massive problem during the data collection process of this research.

Another change in the method can be made by randomizing stimulus sequence for each participant. This can either be done by video editing or recording multiple videos. We believe this has not changed results for our main hypotheses, although had an impact on our preliminary results.

Taken altogether, our results provide support on cognitive level to the view that underlying mechanisms of direct and observational fear learning are similar; while giving new information about the explicit and implicit levels of learning. These results will be helpful in the process of understanding the observational fear learning mechanisms, which has clinical implications for understanding the psychological disorders. Also, considering the view that social learning might be a building block of culture and affect biological evolution in the process by Olsson and Phelps (2007),

these contributions to the literature on observational fear learning will help understanding much deeper mechanisms at work throughout the history of humanity.

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Experience	Behavior change	Category
Stimulus	Response evocation	Habituation
		Sensitization
	Learning	Latent inhibition
		Perceptual learning
Stimulus-stimulus	Response evocation	Pavlovian conditioning
	Learnability	Blocking
		Overshadowing
Response-reinforcer	Response evocation	Instrumental conditioning
	Learnability	Blocking
		Overshadowing

Figure 1. Categories of learning (adapted from Heyes, 1994).

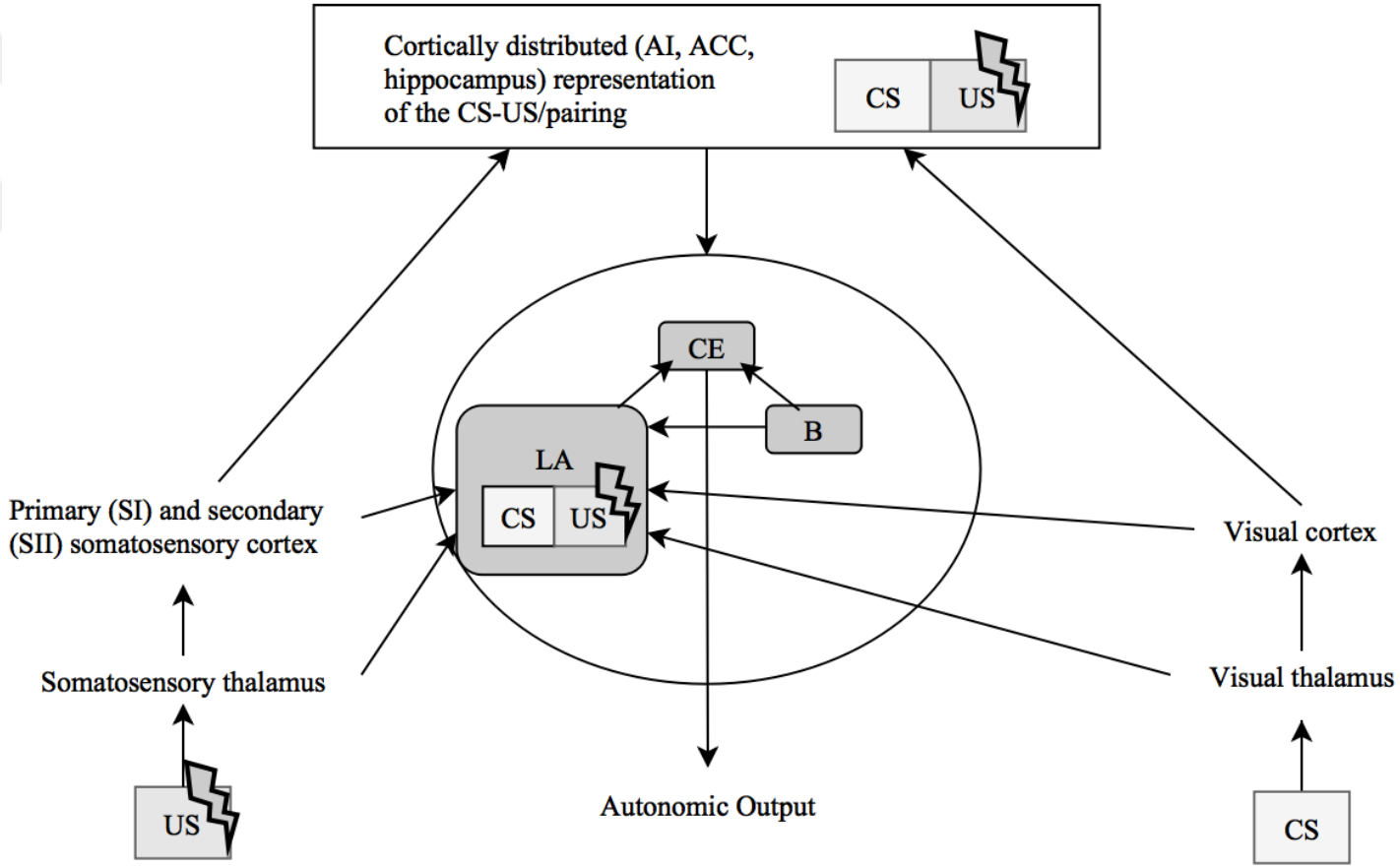

Figure 2. A neural model of direct fear conditioning in humans (adapted from Olsson and Phelps, 2007).

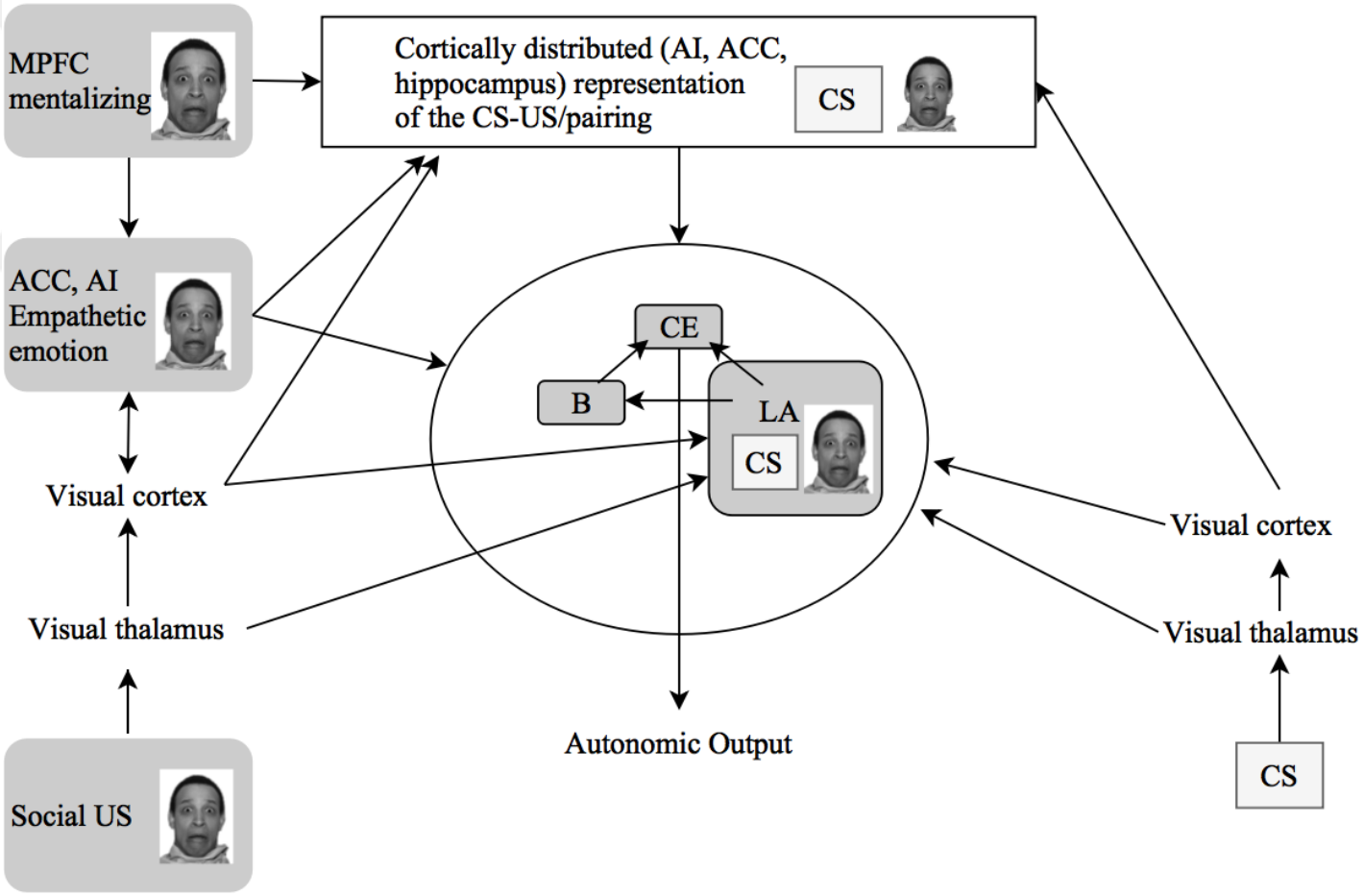

Figure 3. A neural model of observational fear conditioning in humans (adapted from Olsson and Phelps, 2007).

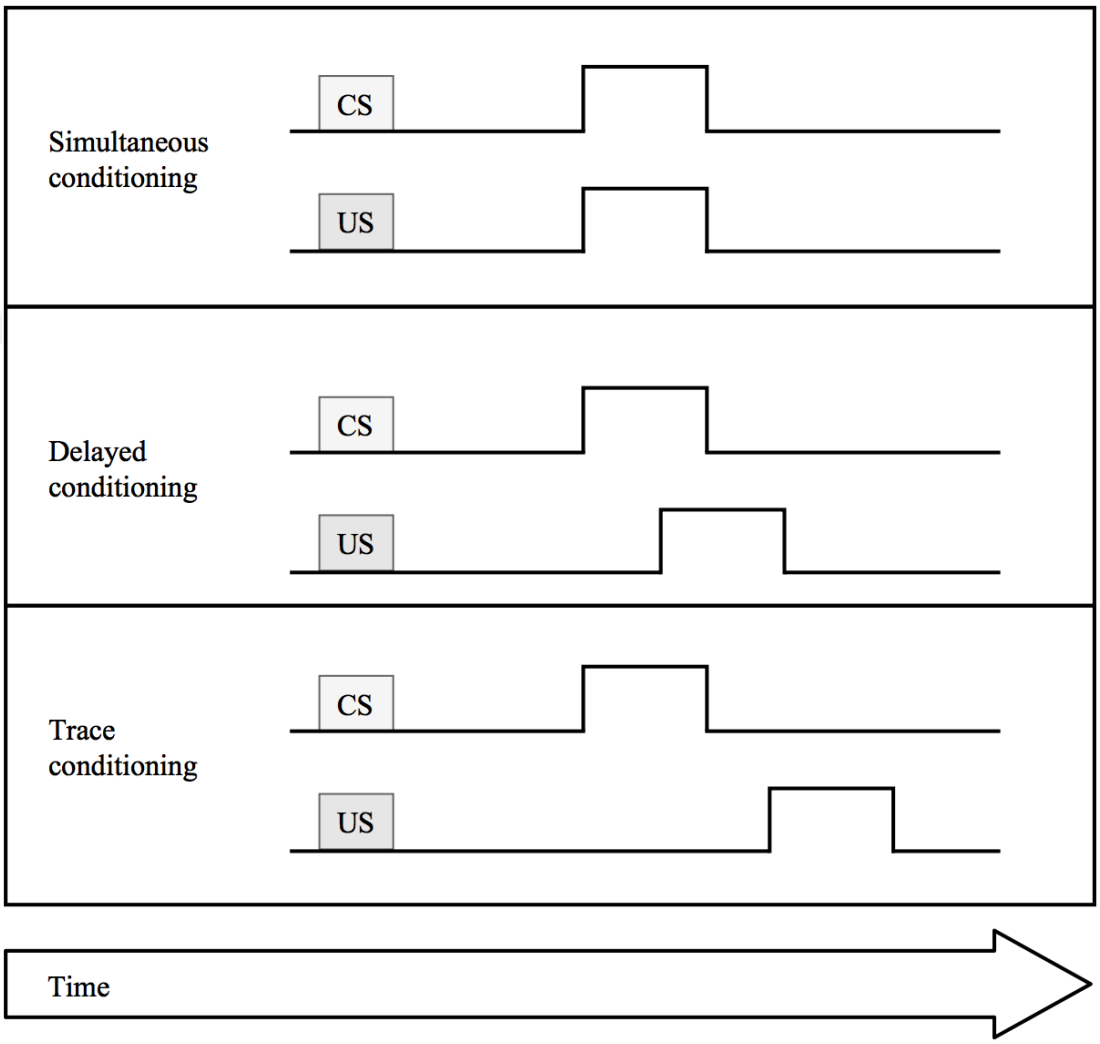

Figure 4. Procedures for (a) simultaneous, (b) delayed, and (c) trace conditioning (adapted from Domjan, 2005).

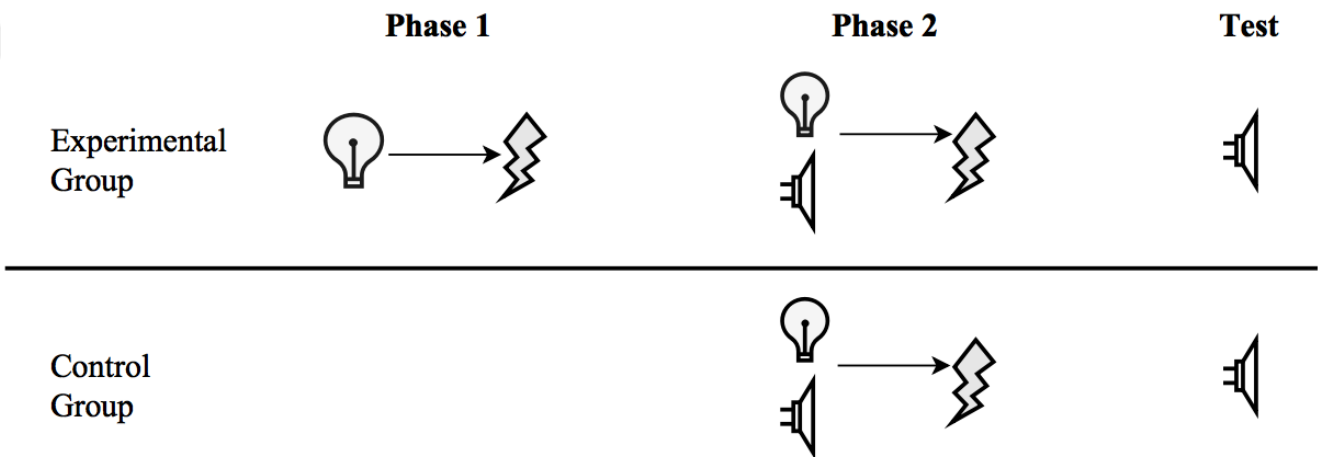

Figure 5. A standard procedure of blocking paradigm (adapted from Domjan, 2005).

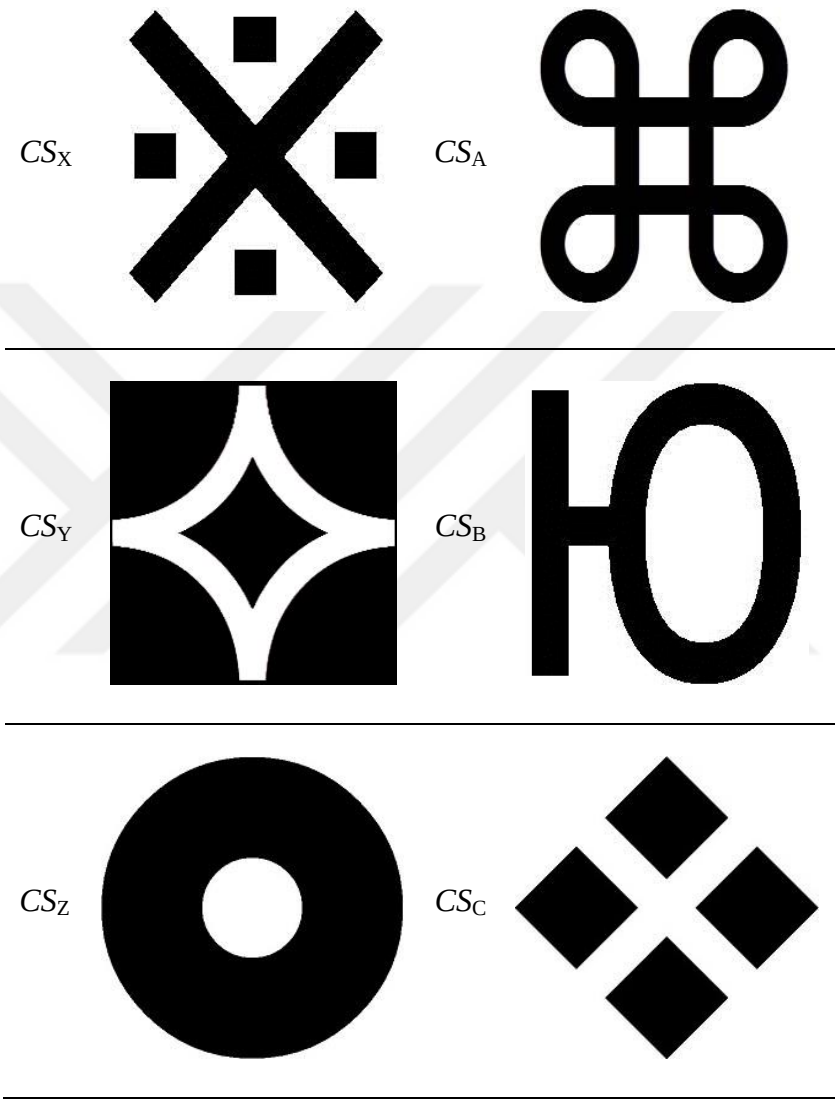

Figure 6. The stimuli used during the experiment.

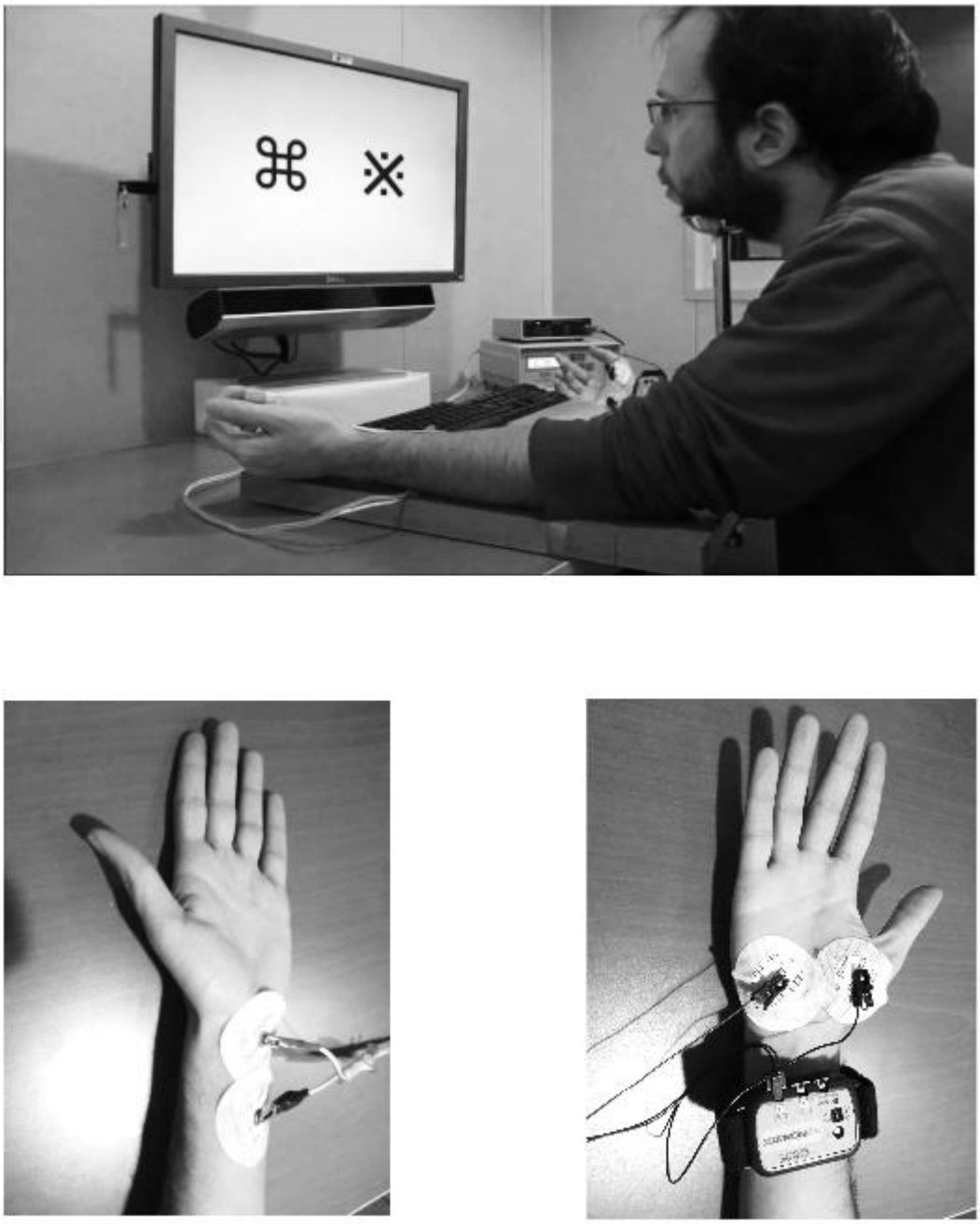

Figure 7. The model and the placement of the electrodes during the recreated video sessions.

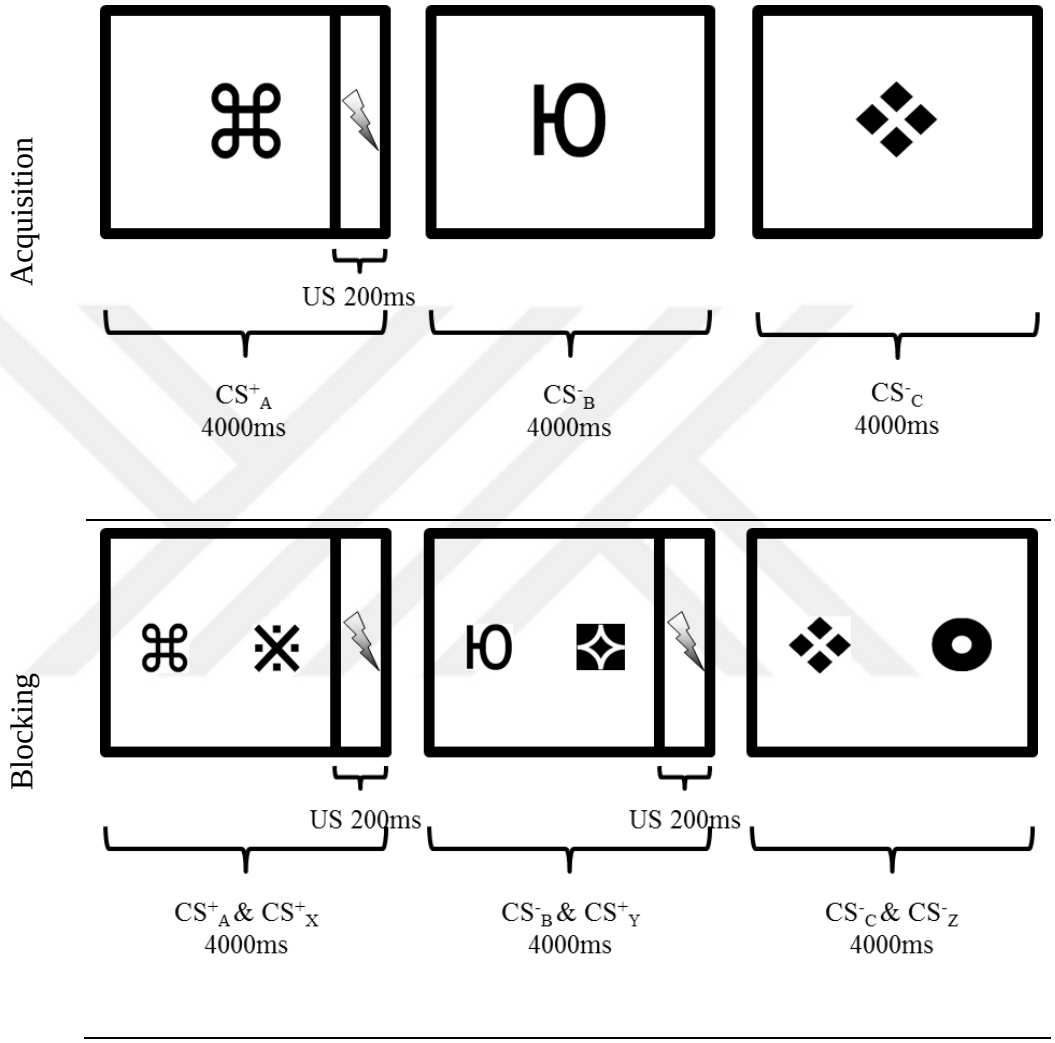

Figure 8. The procedure followed in the videos. Each stimulus was presented 6 times.

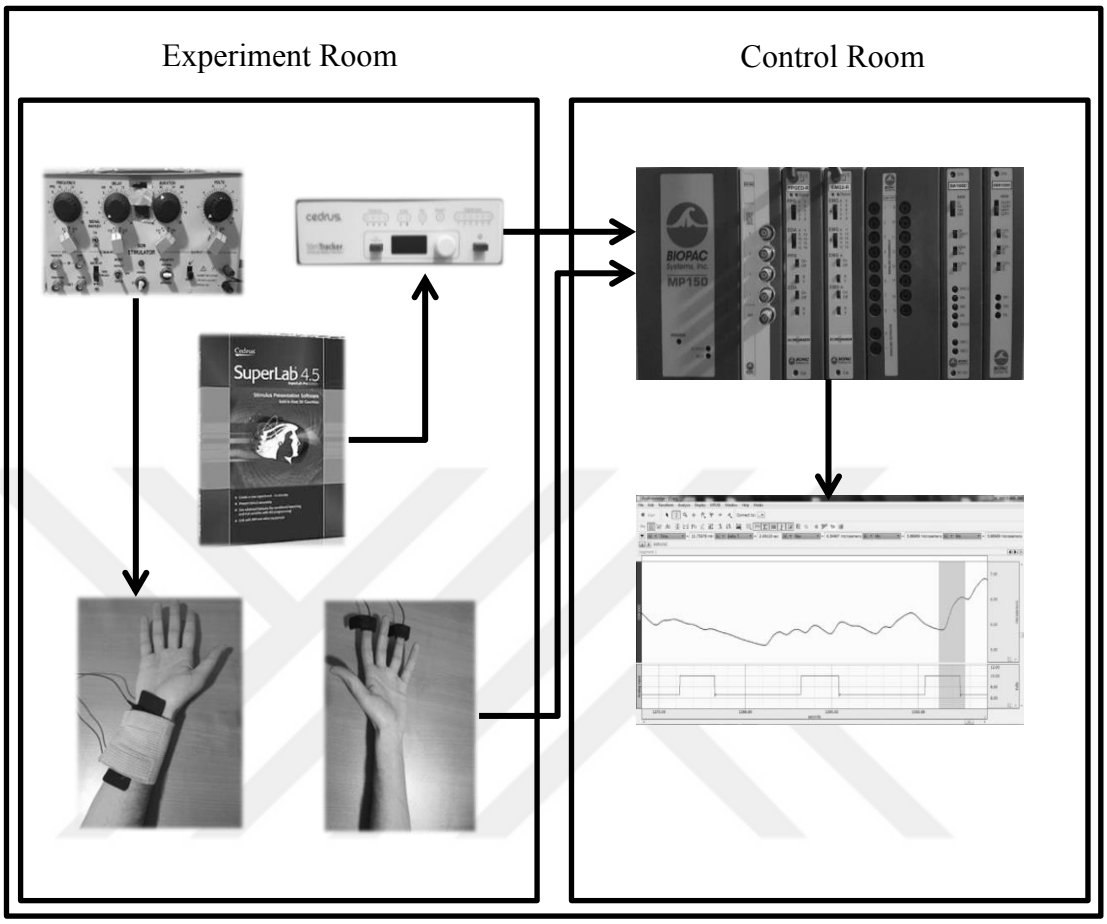

Figure 9. Integration of the experimental setup to the data acquisition system within the experimental and control rooms. In the experimental room, a computer running SuperLab software was used for stimulus presentations. StimTracker detected the stimulus changes on the screen via the photocell, and sent the information to MP system which then projected this data to AcqKnowledge. Electrodermal activity was also obtained through MP system and recorded by AcqKnowledge software. Electrical stimulus box was only used to administer mild shocks in the beginning of the experiment, therefore it was not connected to any systems.

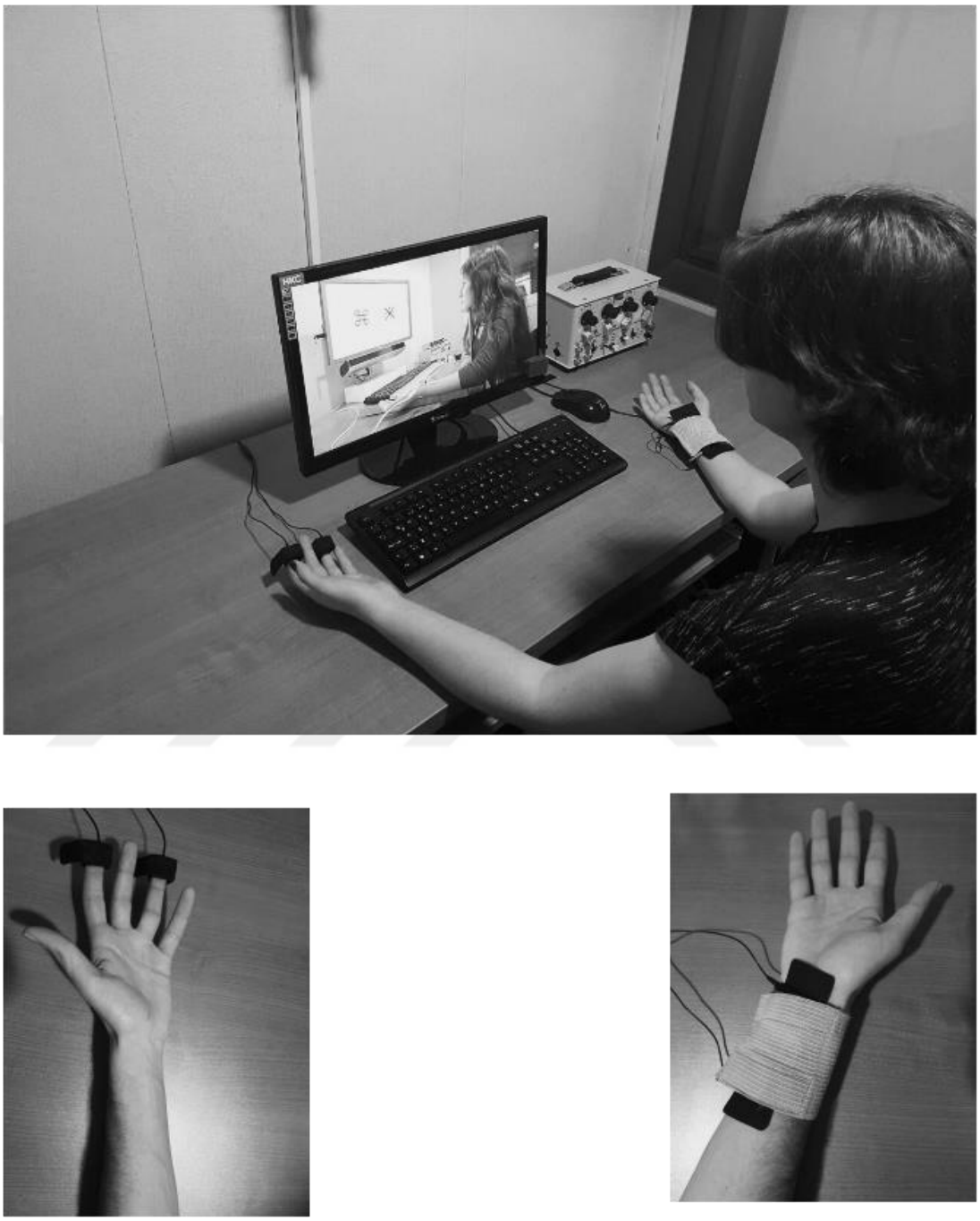

Figure 10. The participant and the placement of the electrodes during the experimental sessions.

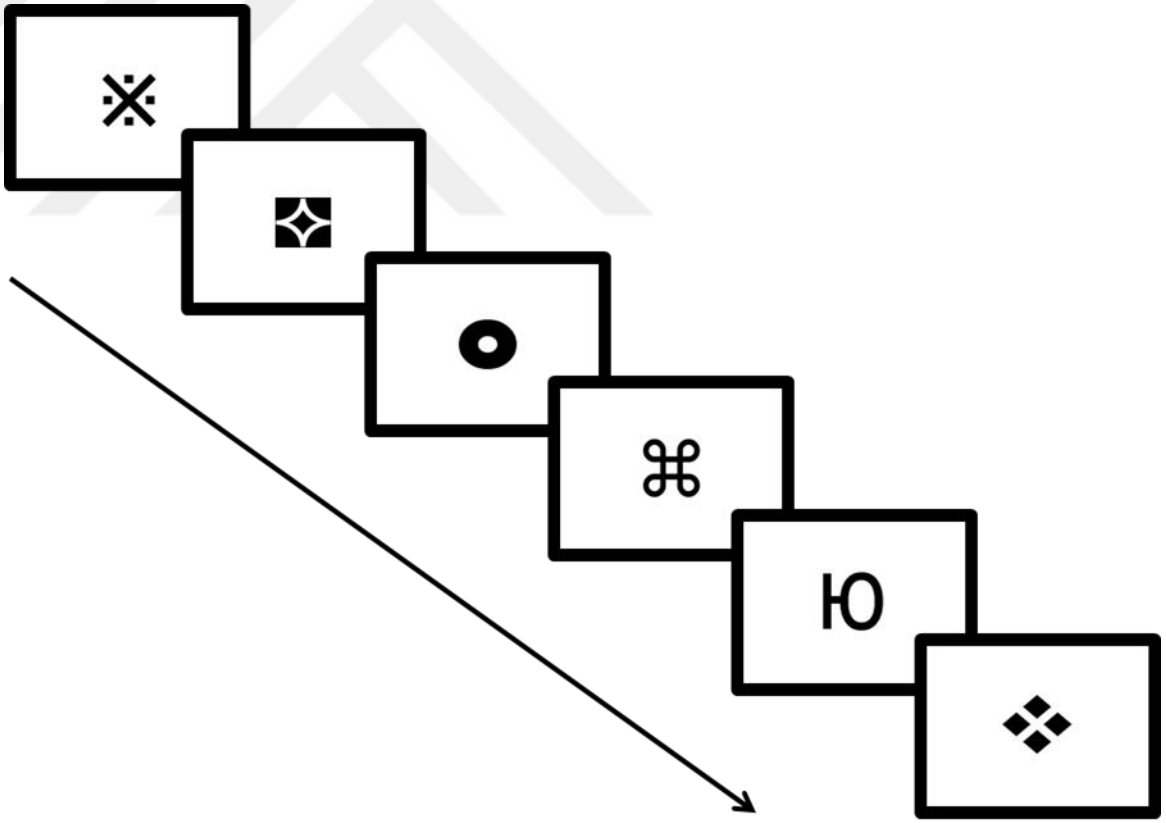

Figure 11. Flow schema for test phase, where all stimuli are shown as single stimuli, each lasting 4000ms with an inter-trial interval of 10s.

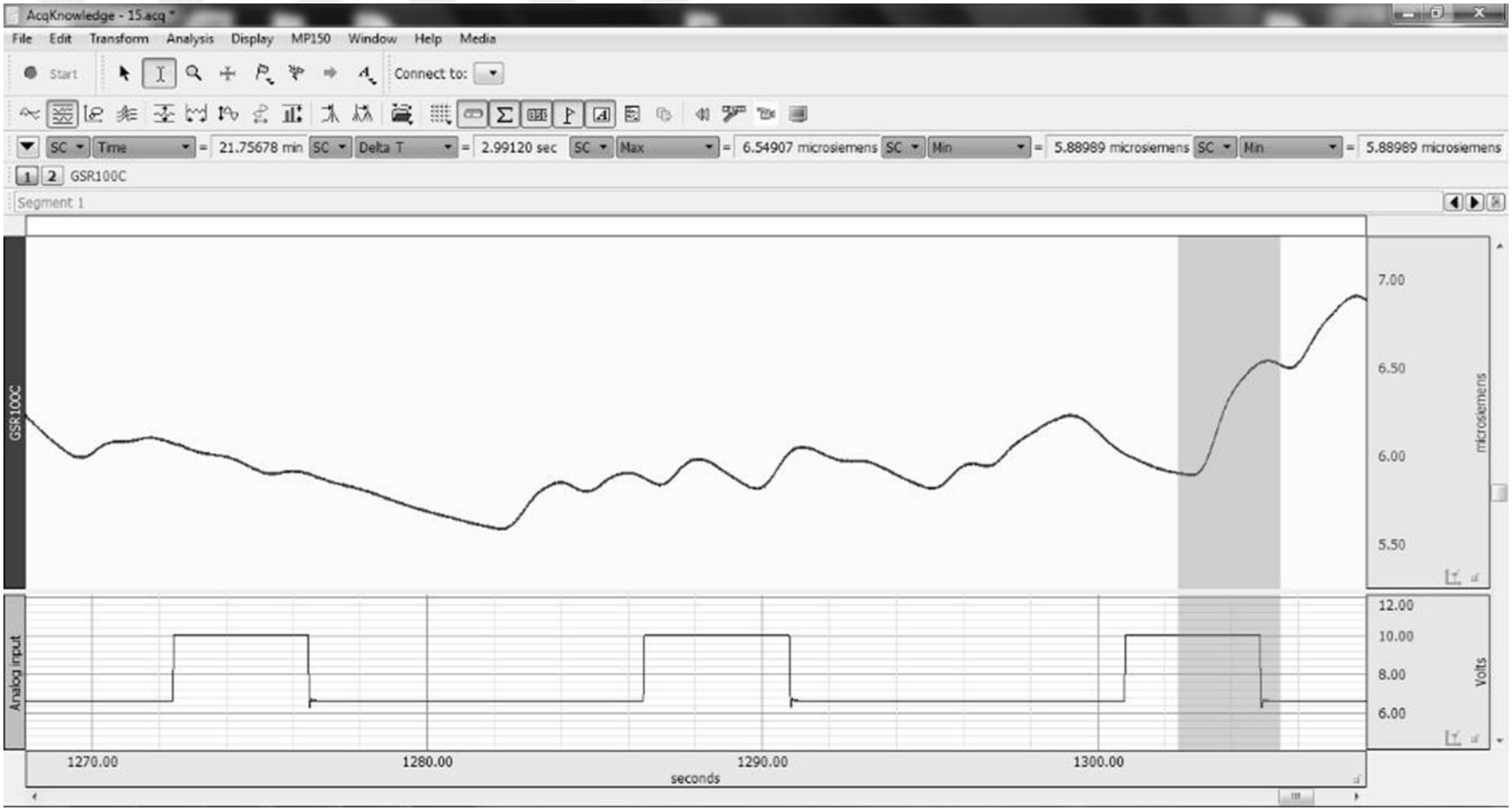

Figure 12. A sample data recorded by AcqKnowledgeTM 4.2.

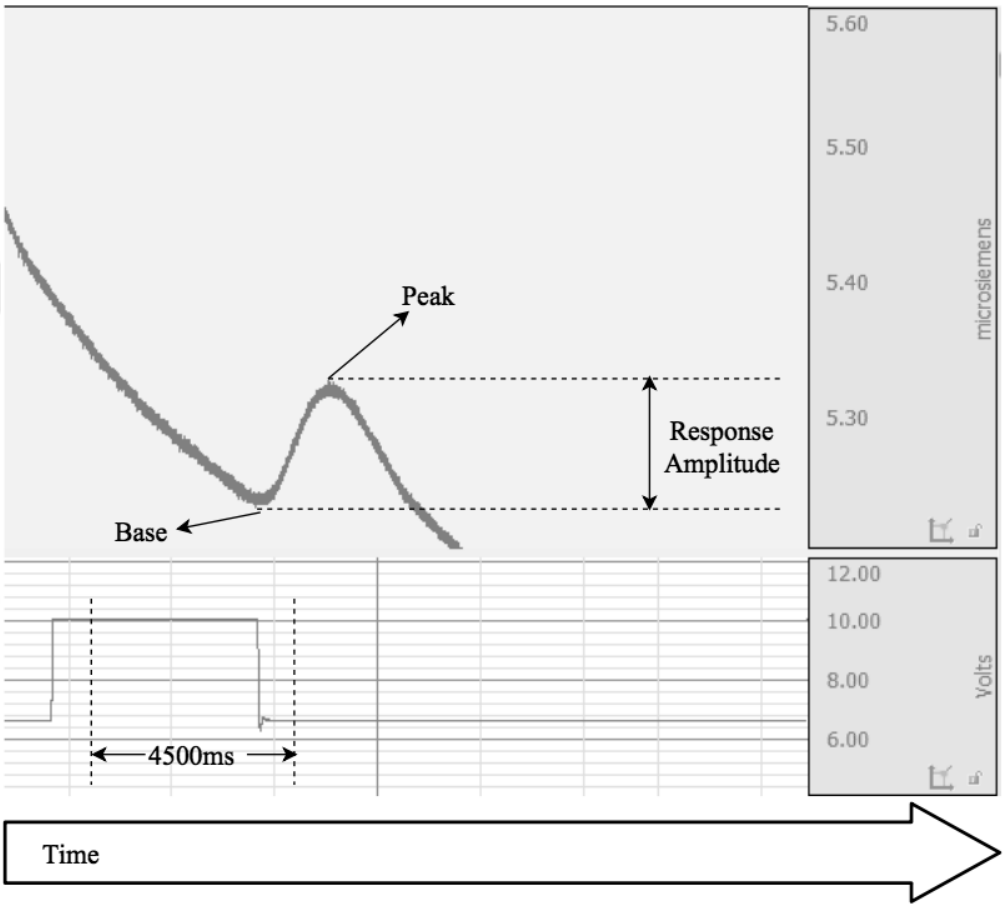

Figure 13. Measurement of skin conductance response given to a single stimulus.

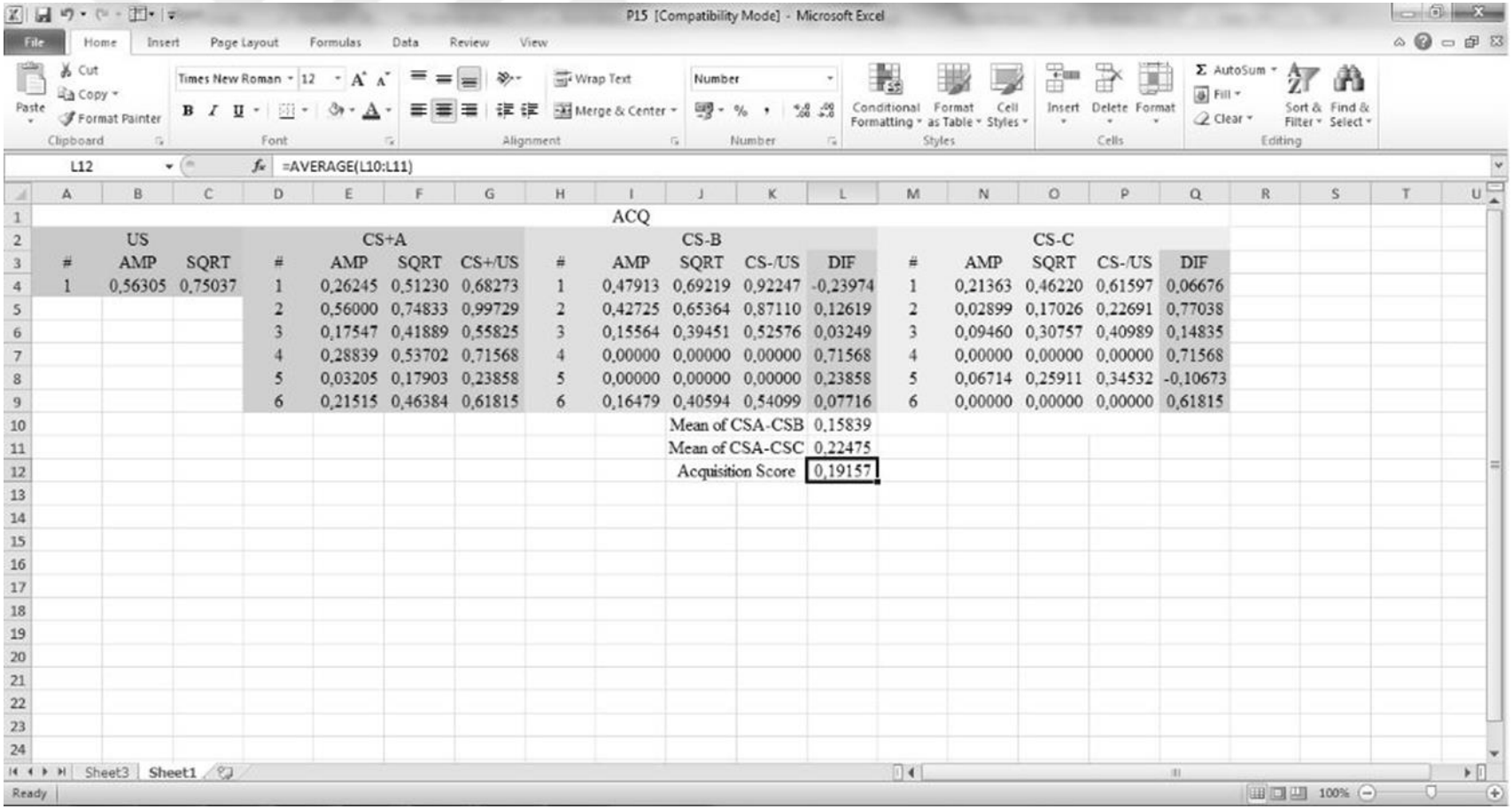

Figure 14. Calculation sheet of acquisition scores.

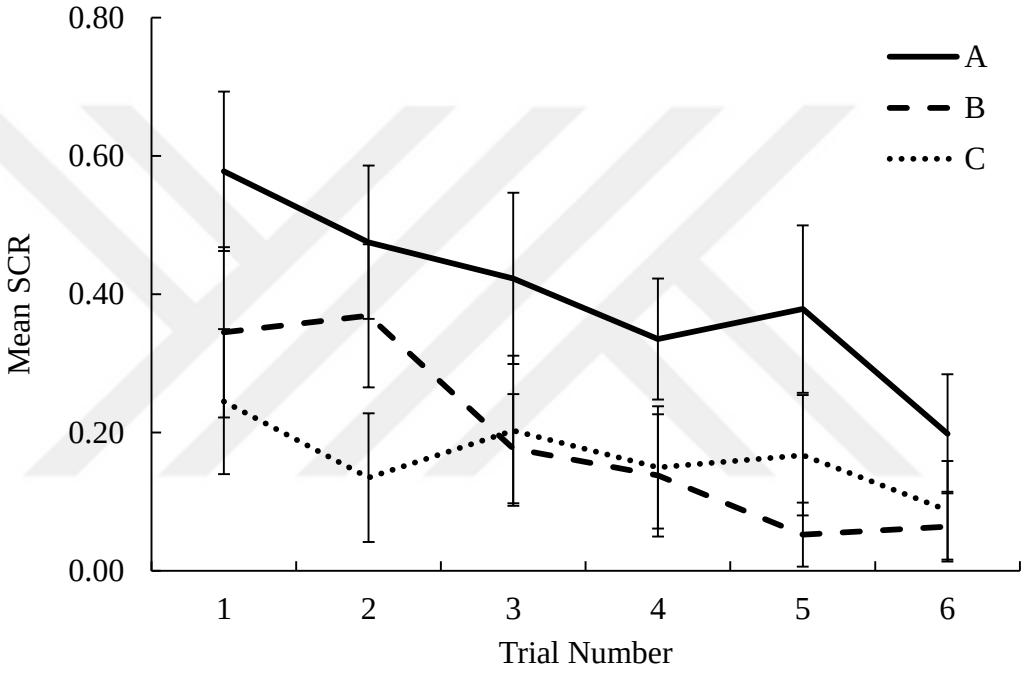

Figure 15. Mean responses to stimuli throughout the trials in acquisition phase (Error bars indicate 95% CI).

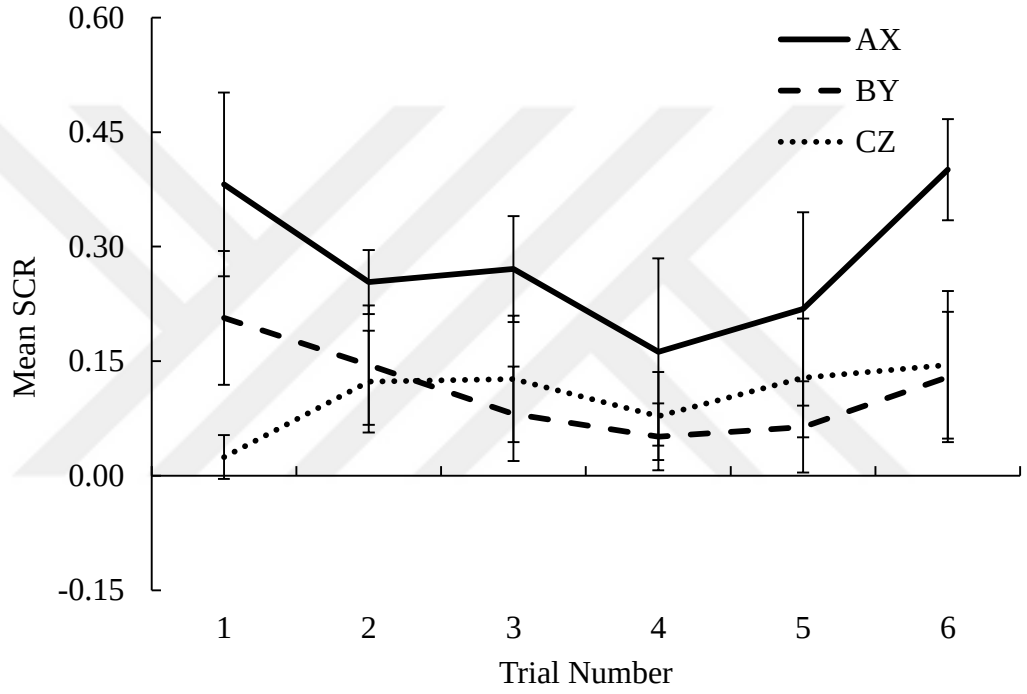

Figure 16. Mean responses to stimuli throughout the trials in blocking phase (Error bars indicate 95% CI.

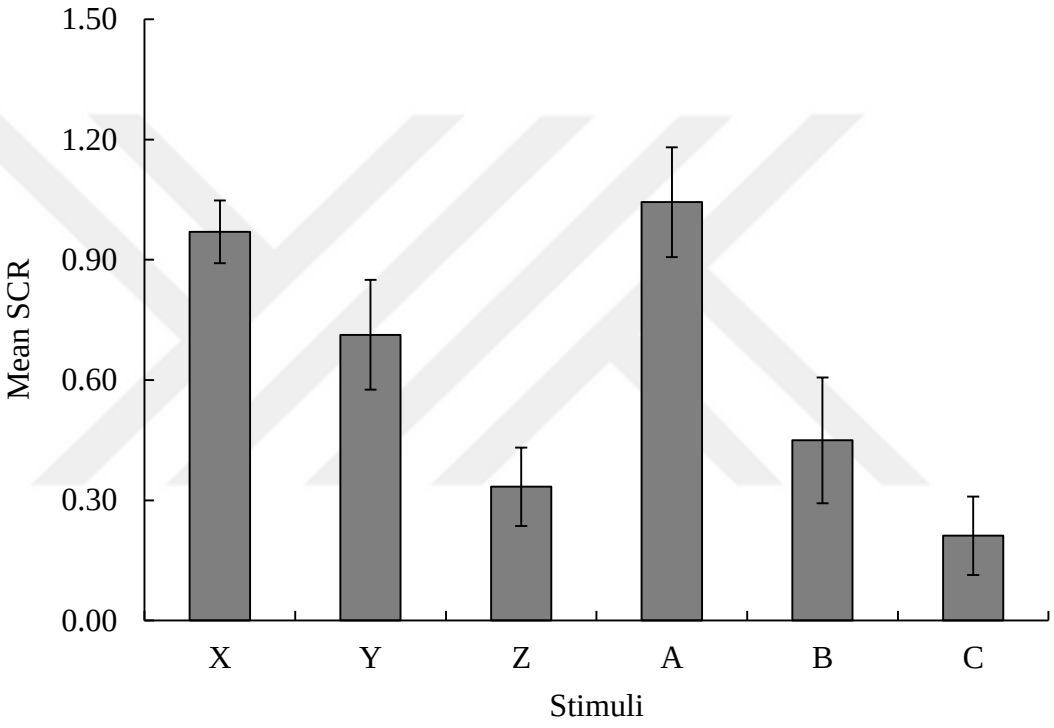

Figure 17. Mean SCR given to presented stimuli during test phase (Error bars indicate 95% CI).

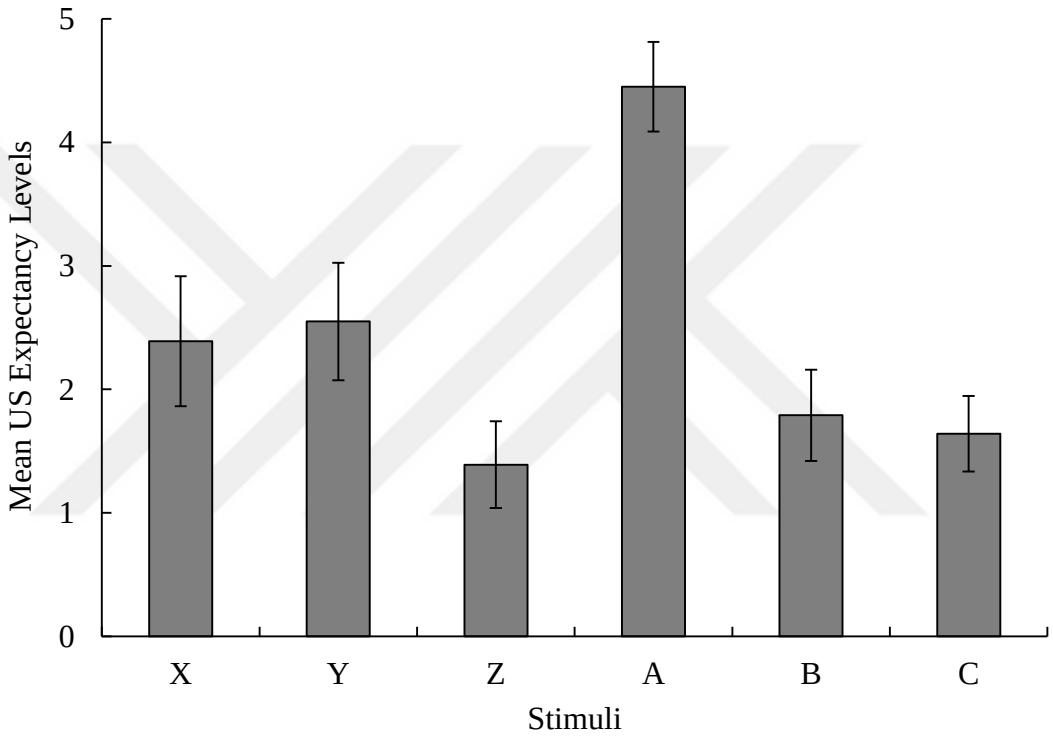

Figure 18. Mean US expectancy levels for presented stimuli during test phase (Error bars indicate 95% CI).

Appendix A

"Informed Consent Form" given to participants before experimental session.

İZMİR EKONOMİ ÜNİVERSİTESİ PSİKOLOJİ LABORATUVARI

KATILIMCI İZİN FORMU

Bu araştırma ile, birtakım uyarıcıların elektriksel uyarımla eşlenmesi yoluyla geliştirilen fizyolojik tepkiler üzerindeki bloklama etkilerinin incelenmesi amaçlanmıştır.

Çalışma süresince bilgisayar ekranından birtakım uyarıcılar sunulacaktır. Bu uyarıcılardan bazıları, sağ kol bileğinize bağlanacak olan elektrotlar aracılığıyla verilen hafif bir elektriksel uyarım ile sonuçlanacaktır. Elektrotlardan verilecek olan elektriksel uyarımın şiddetini araştırmanın başında -sizi rahatsız edecek, fakat canınızı yakmayacak bir düzeyde olacak biçimde- sizin belirlemeniz istenecektir. Bilgisayar ekranından sunulan uyarıcılara verdiğiniz fizyolojik tepkiler, sol elinize yerleştirilecek elektrotlar aracılığıyla ölçülecektir.

Çalışma kapsamında katılımcılardan elde edilen veriler, isim kullanılmaksızın analizlere dahil edilecektir; yani çalışma sürecinde size bir katılımcı numarası verilecek ve isminiz araştırma raporunda yer almayacaktır.

Çalışmaya katılmanız tamamen kendi istediğinize bağlıdır. Katılımı reddetme ya da çalışma sürecinde herhangi bir zaman diliminde devam etmeme hakkına sahipsiniz. Eğer görüşme esnasında katılımınıza ilişkin herhangi bir sorunuz olursa, araştırmacıyla iletişime geçebilirsiniz.

"Informed Consent Form" given to participants before experimental session (cont.).

İZMİR EKONOMİ ÜNİVERSİTESİ PSİKOLOJİ LABORATUVARI

KATILIMCI İZİN FORMU

Çalışmanın amacını ve içeriğini ..... katılımcı numarasına sahip katılımcıya açıklamış bulunmaktayım. Çalışma kapsamında yapılacak işlemler hakkında katılımcının herhangi bir sorusu olup olmadığını sordum ve katılımcı tarafından yöneltilen bütün soruları yanıtladım.

Tarih: Araştırmacının İmzası:

..... / ..... / ....

Çalışmanın amacı ve içeriği hakkında açıklamaları okudum. Araştırmacı çalışma kapsamındaki haklarımı ve sorumluluklarımı açıkladı ve kendisine yönelttiğim bütün soruları açık bir şekilde yanıtladı. Sonuç olarak, uygulama esnasında şahsımdan toplanan verilerin bilimsel amaçlarla kullanılmasına izin verdiğimi ve çalışmaya gönüllü olarak katıldığımı beyan ederim.

Tarih: Katılımcının İmzası:

..... / ..... / ....

Appendix B

"Participant Evaluation Form" given to participants before experimental session.

İZMİR EKONOMİ ÜNİVERSİTESİ PSİKOLOJİ LABORATUVARI

KATILIMCI BİLGİ FORMU

BÖLÜM:

CİNSİYET:

YAŞ:

İLETİŞİM BİLGİLERİ (zorunlu değildir):

Aşağıdaki soruları yanıtlarken lütfen durumunuzu en iyi yansıtan seçeneğin yanına işaret koyunuz.

1. Aktif olarak kullandığınız eliniz hangisi?

- ☐ Sağ
- ☐ Sol

2. Herhangi bir psikolojik rahatsızlık geçirdiniz mi?

- ☐ Evet
- ☐ Hayır

Yanıtınız evet ise 3. sorudan devam ediniz. Yanıtınız hayır ise 5. soruya geçiniz.

3. Bir ruh sağlığı çalışanı tarafından rahatsızlığınıza konulan tanı nedir?

……

"Participant Evaluation Form" given to participants before experimental session (cont.).

4. Rahatsızlığınız için ilaç tedavisi uygulandı mı?

- ☐ Evet
- ☐ Hayır

5. Herhangi bir obje veya duruma karşı fobiniz var mı? (örn: belirli bir hayvan, yükseklik, kalabalık, dişçi vs.)

- ☐ Evet, …….fobisi
- ☐ Hayır

Yanıtınız evet ise 6. soruya, hayır ise 7. soruya geçiniz.

6. Bir ruh sağlığı çalışanı tarafından bu fobinizle ilgili bir tanı aldınız mı?

- ☐ Evet
- ☐ Hayır

7. Yakın zamanda (son 1 sene dahil) başka bir psikoloji deneyine katıldınız mı?

- ☐ Evet, …….. konulu deneye katıldım.
- ☐ Hayır

8. Herhangi bir kalp rahatsızlığı tanısı aldınız mı?

- ☐ Evet
- ☐ Hayır

Yanıtınız evet ise 9. sorudan, hayır ise 10. sorudan devam ediniz.

9. Size konulan tanıyı belirtiniz:

……

"Participant Evaluation Form" given to participants before experimental session (cont.).

10. Herhangi bir ameliyat/operasyon geçirdiniz mi?

- ☐ Evet
- ☐ Hayır

Yanıtınız evet ise 11. sorudan, hayır ise 12. sorudan devam ediniz.

11. Geçirdiğiniz ameliyatı/operasyonu lütfen belirtiniz.

Ameliyat/operasyon:……..

Ameliyat/operasyon tarihi:……..….....……

12. Vücudunuzun herhangi bir yerinde protez/implant var mı?

- ☐ Evet
- ☐ Hayır

Yanıtınız evet ise 13. sorudan, hayır ise 14. sorudan devam ediniz.

13. Lütfen protezin/implantın nerede olduğunu ve özelliğini belirtiniz.

Protez/implant:……

Protez/implantın yapı maddesi:…….….

14. Düzenli/sürekli olarak kullandığınız ilaçlar var mı?

- ☐ Evet
- ☐ Hayır

Yanıtınız evet ise 15. soruyu yanıtlayınız.

15. Lütfen kullandığınız ilaç(lar)ı ve ilaç(lar)ın kullanım amacını belirtiniz.

İlaç(lar):……..…

Kullanım amacı:……..……..…..

“Participant Evaluation Form” given to participants before experimental session (cont.).

Aşağıdaki belirtileri bugün de dahil olmak üzere son bir hafta içinde ne ölçüde yaşadığınızı göz önünde bulundurarak yanıt veriniz.

	Hiç	Hafif	Orta	Ağır
Bedeninizin herhangi bir yerinde uyuşma/karıncalanma				
Sıcak/ateş basmaları				
Bacaklarda halsizlik, titreme				
Gevşeyememe				
Çok kötü şeyler olacak korkusu				
Baş dönmesi/sersemlik hissi				
Kalp çarpıntısı				
Dengeyi kaybetme korkusu				
Dehşete kapılma				
Sinirlilik				
Boğuluyormuş gibi olma duygusu				
Ellerde titreme				
Titreklik				
Kontrolü kaybetme korkusu				
Nefes almada güçlük				
Ölüm korkusu				
Korkuya kapılma				
Midede hazımsızlık/rahatsızlık hissi				
Baygınlık				
Yüz kızarması				
Terleme (sıcağa bağlı olmayan)				