DOES STRESS ENHANCE LATENT INHIBITION?

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ABSTRACT

DOES STRESS ENHANCE LATENT INHIBITION?

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This work evaluated the influence of stress on latent inhibition performance in humans. Latent inhibition refers to the situation where an observer has difficulties creating associations when encountering an irrelevant but familiar stimulus. Sing-a-song test was used as a stress manipulation to induce the mental stress in short time. Participants were asked to sing a song in an unpredictable moment while they were videotaped. This resulted in an increase in skin conductance level and heart rate. Latent inhibition task was used to measure the effect of familiarity on learning. Preexposed stimulus was presented 20 times in the preexposure phase. In the test phase, target stimulus followed each preexposed stimulus and a novel stimulus 20 times. Participants had to respond to the target stimulus. The results of the analysis indicated that reaction time for preexposed stimulus was higher than reaction time for non-preexposed stimulus. Consistent with some literature, stress was found to have significant impact on latent inhibition in the current study. Statistically significant difference was found between stress and non-stress groups for

preexposed stimulus. In other words, preexposed stimulus had higher reaction time in stress group than preexposed stimulus in non-stress group. Similarly, non-preexposed stimulus had higher reaction time in stress group than non-preexposed stimulus in non-stress group.

Keywords: latent inhibition, stress, heart rate, sing-a-song stress test, skin conductance response

ÖZET

STRESİN ÖRTÜK KETLEME ÜZERİNDE ARTTIRICI BİR ETKİSİ VAR MIDIR?

Hasanli, Sayyara

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Bu çalışmada insanlardaki stress düzeyinin örtük ketleme peformansları üzerindeki etkisi incelenlenmiştir. Örtük ketleme, gözlemcinin görevle ilgisiz fakat tanıdık bir uyaranla karışılaştığı zaman uyaranlar arasında bağlantı kurmada yaşadığı zorlanmayı ifade eder. Bu tezde, kısa süreli olarak zihinsel stresi manipule etmek amacıyla bir şarkı söyleme testi kullanılmıştır. Katılımcıların davranışları deney boyunca video kaydına alınırken, stres manipulasyonu olarak beklemedikleri bir zamanda şarkı söylemeleri istendi. Yaratılan stres manipulasyonuna bağlı olarak katılımcıların şarkı söyledikleri sırada deri iletkenlik seviyelerinde ve kalp atışlarında anlamlı bir artış gözlemlendi. Daha sonra, tanıdıklık etkisinin öğrenme üzerindeki etkisini ölçmek için örtük ketleme testi kullanıldı. Çalışmanın önceden maruz bırakma aşamasında önceden maruz bırakılmış uyarıcı 20 kez sunuldu. Test aşamasında, 20 kez her bir önceden maruz bırakılmış uyarıcı ve katılımcının yeni karşılaştığı uyarıcıdan sonra görev olan uyarıcı katılımcıya sunuldu ve görev olan uyarıcıyı her gördüklerinde cevap vermeleri istendi. Analiz sonuçlarına göre, katılımcıların önceden

maruz bırakılmış uyarıcılara verdiği tepki süreleri önceden maruz bırakılmamış uyaranlara verdikleri tepki süresinden daha uzundu. Literatür geçmişiyle paralel olarak, bu çalışmada da stresin örtük ketleme üzerinde anlamlı bir etkisi olduğu gözlemlenmiştir. Stresin manipulasyon olarak kullanıldığı ve kullanılmadığı iki grubun önceden maruz bırakılmış uyarıcı için tepki süresi karşılaştırıldığında gruplar arasında anlamlı bir fark gözlemlendi. Diğer bir değişle, önceden maruz bırakılmış uyarıcılara stres manipulasyonuna mağruz kalan grubun tepki süresi, stres manipulasyonuna mağruz kalmayan grubun tepki süresine nazaran daha uzundur. Benzer olarak, önceden maruz bırakılmamış uyarıcıların test edildiği grupta, stres manipulasyonuna mağruz kalan katılımcıların tepki süresi, stres manipulasyonuna mağruz kalmayan katılımcıların tepki süresine göre daha uzundur. Sonuçlara bağlı olarak, stresin örtük ketleme üzerinde arttırıcı bit etkisi olduğu gözlemlendi.

Anahtar Kelimeler: örtük ketleme, stres, kalp atım hızı, bir şarkı söyleme testi, deri iletkenliği seviyesi

To Lale aka Nur, 6-month-old. May you Rest in Peace, little angel!

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CHAPTER I: INTRODUCTION

The main goal of this thesis is to investigate the latent inhibition (LI) effect and to demonstrate the effect of stress on LI performance. In classical conditioning paradigm, LI refers to the situation in which an observer has more difficulty creating associations when encountering an irrelevant but familiar stimulus. In other words, this term holds to the observation that for a familiar stimulus to acquire meaning as conditioned stimulus (CS), more time is needed than for a non-familiar, novel stimulus. Moreover, stress is found to impair concentration and task completion; however, the interaction between the LI effect and stress is not well understood in humans. This topic of study was selected as an appropriate Master's thesis as it offers a novel contribution to the field by examining the effect of stress on LI in a human sample.

1.1 Latent Inhibition

LI can be defined as the phenomenon of experiencing retarded performance when conducting a learning task where the target stimulus was previously irrelevant, as compared with situations when it was not present (Granger et al., 2016). Specifically, it takes longer to acquire the meaning of objects that we feel, hear, see, taste or smell on a frequent basis than it does to acquire the meaning of a new stimulus. The human brain developed this mental tool to experience the world in a controlled manner.

LI is generally used by humans in daily interactions with their surrounding environment. Different studies have demonstrated that a stimulus will not be as easily associated with the unconditioned stimulus (US) as a novel stimulus if that stimulus is highly familiar (Braunstein-Bercovitz et al. 2004; Allen et al., 2002). It becomes difficult for a stimulus to create new associations when this stimulus is continuously presented as an irrelevant stimulus. The LI phenomenon is not unique to humans and can be observed in other animal species. Lubow (1989) and Hall (1991) were the first researchers who discovered LI in human studies. It is called 'latent' due to not presenting in the stimulus preexposed phase and presenting only in the test phase. 'Inhibition' refers to the expression of the effect due to impaired learning. LI can appear in all mammalian species and plays a role as an adaptive tool that helps organisms filter out irrelevant stimuli and focus on important events. There are two stages – preexposed (PE) and test stages – in a typical LI task performed with humans. In the PE phase, the insignificant stimulus is presented alongside the stimulus PE group before Pavlovian conditioning trials (Domjan and Grau, 2015). At the same time, a masking task is used to divert attention from the presented insignificant stimulus, which in the test stage will play the role of the target stimulus. A masking task is also used with the non-preexposed (NPE) group, but without the to-be target stimulus. In the test phase, subjects may have to perform the masking task when presented with either the PE stimulus or a new stimulus (NPE stimulus). In the test phase, all subjects have to make associations regarding the presence of the previously insignificant PE stimulus with programmed consequences. In this phase, conditioned

stimulus (CS) is paired with our unconditioned stimulus (US) using regular classical conditioning procedures. When the NPE group reaches a learning criterion faster than the PE group, this is called LI (see Figure 1). In other words, LI occurs when we reduce the attention paid to the insignificant stimulus during the PE phase (Lubow, 1989; Lubow and Gewirtz, 1995) and subjects respond slower due to previously presented CS preexposure. At this point, learning is disrupted by CS preexposure. If this irrelevant stimulus would not be preexposed or it would be relevant and preexposed, then one would pay less attention to this stimulus during the test phase. Some characteristics of LI are similar to habituation. LI and habituation frameworks both involve limited processing and attention to stimuli that are presented alone (in PE phase), therefore rendering the stimuli irrelevant or insignificant. In LI, learning is biased in favor of novel stimuli, whereas in habituation it is elicited behavior that is biased in favor of novel stimuli. The theory that stimulus selectivity is necessary to support quick learning is supported by LI (Lubow and Gewirtz, 1995). LI was originally discovered by Lubow and Moore (1959) by examining the behavior of sheep. Human LI studies followed later, becoming popular three decades ago. These findings confirmed that attention to the CS is reduced by the CS itself, and that the learning is disrupted due to this stimulus.

1.1.1 Animal Studies

Initially, only animal studies were conducted to demonstrate LI. Lubow and Moore (1959) conducted the first studies demonstrating the LI effect. They used the classical conditioning paradigm and worked with sheep and goats. Shocks to the foreleg were applied to play the role of the

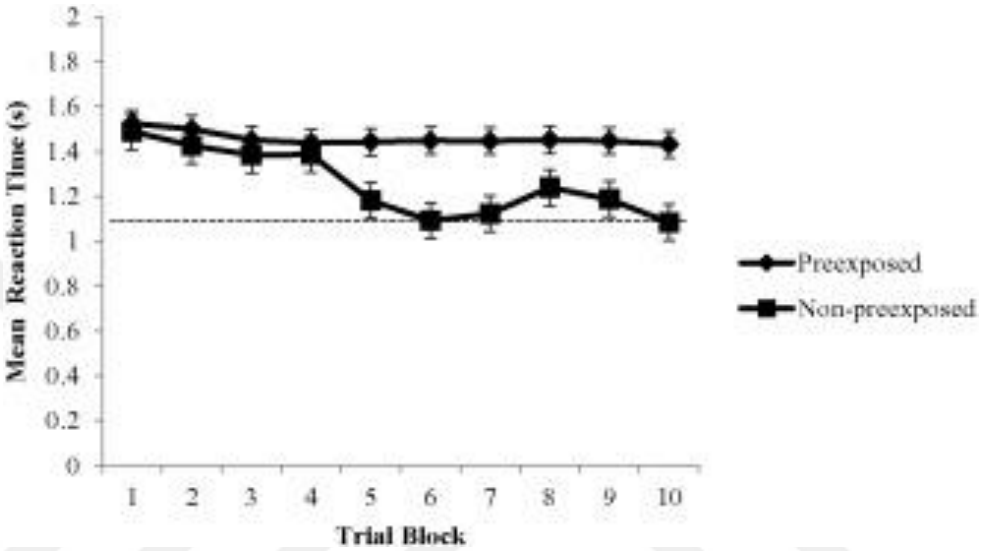

Figure 1. Illustration of LI. Mean reaction times (sec) to the PE and NPE stimuli over the 10 trials in test phase. Slowest reaction time (dotted line) is given to PE stimuli rather than to NPE (squared line). (Adapted from Kiri T. Granger et al., 2016).

US, leg flexion – as unconditioned response (UR), flashing light – as the CS, and to evaluate the CS preexposure effect on the following conditioning trials two experiments were conducted. In the first experiment, CS and US were presented to the same side of the animal; this resulted in a partial inhibition of learning the CS-US associations as compared with a new CS-US. However, when the CS and US were presented on the opposite side of the animal, it resulted in facilitation of CS-US learning. In summary, animals required more trials to respond with a conditional leg flexion to a stimulus that was previously presented as a CS, compared with the number of trials needed for a new stimulus. Seven years later, Lubow (1965) replicated these findings on both sheep and goats. Intensive investigation of LI commenced as a result of their studies.

1.1.2 Human Studies

Lubow (1989) and Hall (1991) conducted the first human studies. Studies showed that LI effect is presented in both schizophrenic and normal patients.

Attentional processes control LI, thus LI theory held that the schizophrenic group must differ from normal patients, as schizophrenia is characterized by attentional deficits (Braff, 1993; Nuechterlein, Dawson 1984). In reality, other researchers have shown that normal patients and longer term medicated, chronic schizophrenic patients have induced LI compared to the medicated, severe schizophrenic patient group (Baruch et al., 1988; Gray et al., 1992; Rascle et al., 2001; Vaitl et al., 2002). However, it was found that LI effect is still apparent in acute schizophrenia patients in different studies (Swerdlow et al., 1996). One of the main

causes for this discrepancy might be the medication used by schizophrenic patients in the studies above.

Baruch et al. (1988) reported that patients were receiving a mean dose of 425.4 mg/day chlorpromazine equivalents; four years later, Grey et al. (1992) claimed that patients received a mean dose of 531.25 mg/day chlorpromazine equivalents. Both groups of patients were then tested within 2 weeks. However, all patients were medication-free for six months before hospitalization. Most patients were receiving phenothiazine- and non-phenothiazine antipsychotics. It was observed that schizophrenia patients needed more trials to reach the learning criterion than normal patients, and this difference was found in both PE and NPE conditions, in both visual and auditory LI tasks. Therefore, it was assumed that the different classes of antipsychotic medications are the main reason for the LI remaining apparent in schizophrenic patients in the study by Swerdlow et al. (1996).

Another study revealed that schizophrenic patients exhibited a slower reaction time (RT) than the control group's RT during all trials and conditions (Nuechterlein, 1977). It is believed oculo-motor dysfunction in the visual search task could be a factor explaining the longer RT (Cohen et al., 2004). The reason that visual searches slow RT can be linked to the variety of problems which schizophrenic patients suffer (Iacono and Clementz, 1993; Sereno and Holzman, 1995). However, oculo-motor dysfunction cannot sufficiently account for the interaction between PE and NPE conditions and group, due to having the same effects in both preexposed and non-preexposed trials. Generally, RTs were faster in the

PE phase than in the test phase; this difference in times can be explained by the fact that targets and distractors were the same on every trial in the PE phase, whereas the targets and distractors were different on every trial in the test phase (Cohen et al., 2004). Different RTs between phases were present in both groups, and RT were significantly less in the control group than in the experimental group (schizophrenic group) (Lubow et al., 2001) due to the increase in load for different tasks (Nuechterlein, 1977).

A few authors created a within-participants LI task that showed strong LI effects where RT and number of correct responses were used as the dependent measures (Evans et al., 2007). The researchers' goal was to determine if there were any effects between LI and gender or their smoking status. According to Lubow et al. (2001), female participants showed less LI than male participants. However, no main effect of gender was found in the study described by Evans, Gray and Snowden (2007). The results showed that when the smoking status was assessed, there was a quicker RT to PE stimulus for smoker participants, and these participants had a higher number of correct responses than the non-smoker group of participants. It is important to note that the faster learning of the stimulus – outcome association was uncommon to the PE stimulus. Nevertheless, a significant difference between smokers and non-smokers in learning the NPE stimulus association was not found. In total, reduced LI was observed in individuals in the smokers group. Further analysis showed that the participants who had smoked a cigarette more than 10 hours before performing the LI task showed greater LI than participants who had smoked a cigarette fewer than four hours before. These results were obtained regardless of whether the

dependent variable was reaction time (RT) or number of correct responses. Accordingly, no differences were found in RT and amount of correct responses to the NPE stimulus between recent (less than 4 hours ago) and non-recent (more than 10 hours ago) smokers. Thus, according to these findings, there is an attenuated LI effect in participants who had smoked cigarette less than four hours ago.

Similar results regarding the reduction of LI in smoker participants were found in the study of Allan et al. (1995), and also in studies using rats (Weiner et al., 1981) and other animals. Furthermore, reduction or abolishment of the LI effect is related to the nicotine-type amphetamine which works as an indirect dopamine agonist. However, due to small number of participants (only 16 non-smokers out of total 80 participants) this statement could not be confirmed.

In order to understand the function of disorders, especially the symptoms associated with schizophrenia, there was a huge step in experimental design from the study of animal learning to human abnormal psychology. As It was mentioned earlier, the disruption of attentional function is one the symptoms of schizophrenia (McGhie and Chapman, 1961; Hemsley, 1987). To model this abnormality of attention in schizophrenia patients, LI design was used (Lubow and Moore, 1959; Lubow, 1973; Hall and Honey, 1989). For accessing the individual schizotypy O-Life (Oxford-Liverpool Inventory of Feelings and Experiences) was used. There are four dimensions in O-life: *unusual experiences* (or UnEx – unusual cognitive and perceptual sensations and magical interpretation of occurring events), *cognitive disorganization* (or

CogDis – is similar to cognitive disorders occurring in schizophrenia regarding formal thought disorders and unconventional chains of thought), *introvertive anhedonia and impulsive nonconformity* (or IntAn – the inability to experience pleasure), *impulsive nonconformity* (or ImpNon – describes a pattern of behavior where people fail to follow social rules or norms). The O-Life questionnaire was used because it shows exact same multi-dimensional structure as schizophrenia, having negative, positive and disorganized symptoms (Mason et al., 1995). UnEx and ImpNon were found to be significant predictors of RT to the PE stimulus, whereas the UnEx reflected slower learning (or enhanced LI) and the ImpNon reflected faster learning (or attenuation of LI). When the other two schizotypy subscales (CogDis and IntAn) were applied, this resulted in finding no significant relationship between reaction time and the PE stimulus. UnEx, CogDis and IntAn were found to be non-significant, whereas ImpNon was only significant and negative predictor of reaction time of NPE, which means faster learning (Granger et al., 2016). There has been some disagreement between researchers regarding the relationship between the positive symptomatology and LI in schizophrenia. As stated above, a positive relationship between LI and positive symptoms was found by some researchers (Vaitl et al., 2002; Rascle et al., 2001; Gray et al., 1992, 2002; Baruch et al., 1988) and no relationship was found by different authors (Williams et al., 1998; Swerdlow et al., 1996; Rascle et al., 2001; Gal et al., 2009; Cohen et al., 2004). Rather than positive symptoms, some negative symptoms in schizophrenia patients were linked with reduced LI (Rascle et al., 2001). However, the work of Cohen and his colleagues

(2004) observed no difference between high levels of positive symptoms in patients with schizophrenia and control patients. According to these results, there is no evidence supporting the relationship between positive symptomatology and LI attenuation. On the contrary, Weiner (2003) proposed that chronic patients inherent the enhanced LI that is related to the negative symptoms. At the same time, there were not any associations between enhanced LI and negative symptoms, but only an association with chronic schizophrenia (Cohen et al., 2004; Gal et al., 2009). It is supposed that the tasks chosen by Cohen et al. and Gal et al. were different in nature: LI confounded with learned irrelevance or/and conditioning inhibition, and therefore there is some discrepancy between these findings.

Shrira & Kaplan (2009) examined schizotypy and selective attention in students. They looked at the relationship between the two and compared student performance in overshadowing (OS) and LI (two models of selective attention), evaluated through the rubric of O-LIFE's psychoticism scales. One of the goals of this study was to examine whether there is a relationship between four types of schizotypy dimensions taken from the O-LIFE and overshadowing scales. It was discovered that scores for the four dimensions of O-LIFE were similar to the population norms described by Mason and his colleagues (Mason et al., 1995). Analysis, particularly stepwise regression, showed that regardless of the type of task (whether it is OS measured within task-OS1, or between task-OS2), the only dimension that predicted OS was UnEx. Hence, reduced OS will be seen in participants who had a higher score on the UnEx.

Some studies that compared masked and non-masked conditions have showed that non-masked conditions failed to produce LI (Braunstein-Bercovitz & Lubow, 1998). Shrira and Kaplan (2009) investigated how LI is moderated by gender, class of schizotypal symptom and type of within-subject procedure. The within-subject procedure was performed with a masking task and without a masking task. It was found that stimulus PE effect is strengthened or attenuated depending on the total schizotypy score in the procedure only when the masking task is performed. Further analysis revealed that there was an interaction between gender and positive schizotypy. In other words, males showed a weakened PE effect compared to females with high positive schizotypy. However, other authors determined the opposite direction of the interaction, i.e. low-schizotypal males and high-schizotypal females exhibited attenuated LI (Lubow et al., 2001; Lubow & De la Casa, 2002). Voglmaier et al. (2005) showed that female schizotypal patients have less cognitive deficits in comparison with male patients, whereas high-schizotypal males are more likely to exhibit effects different from typical LI effects. Indeed, after controlling the significance of PE *x* positive schizotypy *x* gender interaction, a contribution from NPE and PE conditions was found. To summarize, in the study above, it was observed that it was possible to demonstrate effects other than LI when there was a within-subject task without a masking procedure. The effects that were found to be different from LI were shown in both NPE and PE conditions; even though this result was inconsistent with previous findings, they had an interaction with schizotypy factors in this study (Shrira and Kaplan, 2009). Escobar et al. (2003) and Evans et al.

(2007) suggested that valid LI effects can be produced by non-masking stimulus PE procedures, and these results are relevant to the results described above. On the contrary, it was observed that no instructions and no-masking before the test phase may enforce effects other than LI (Shrira and Kaplan, 2009).

1.1.3 Neural Substrates of Latent Inhibition

There were few approaches regarding the theory of LI from different authors. One group of researchers suggested that it is the storage of CS-US associations that is disrupted due to CS-preexposure. According to scholars supporting this theory, this is due to either decreasing the CS associability (Lubow et al., 1981; Schmajuk & DiCarlo, 1991) or encouraging the CS with no US association formations (Revusky, 1971; Testa & Ternes, 1977). Hence, the mechanism that operates during the memory storage phase explains LI. Other group of investigators claimed that CS-preexposed prevents the retrieval of CS-US associations. In other words, CS-preexposure destroys the following retrieval of associations between CS and US (Kasprow et al., 1984; Kraemer et al., 1991). Consequently, according to the second approach, the result of the mechanism that operates during the memory retrieval also explains LI.

Weiner found that noradrenergic and cholinergic systems do not play any role in the formation of LI (Weiner, 1990). However, a few researchers that conducted studies with drugs demonstrated the importance of the dopaminergic system, as amphetamine is a dopamine (DA) releaser, which disrupts LI, and haloperidol is a DA blocker, which facilitates LI. It is necessary to emphasize that when these drugs were administered in the

PE phase, they did not have an effect on LI. Other studies found that the septo-hippocampal system is also involved, since the hippocampus and septum lesions are responsible for disrupting LI. Further analysis also showed that the serotonergic system is also involved, as it can cause disruption of LI due to brain serotonin depletion (Solomon et al., 1978; Lorden et al., 1983). Weiner (1990) suggested the switching model of latent inhibition. When this model was in the stage of formulation, LI theories were initially focused on the processes occurring during the PE phase, and attempted to determine the exact nature of these processes. According to the switching model the relationship between the PE stimulus and novel stimulus is acquired during PE phase; this relationship is generally accepted by researchers. Nevertheless, the switching model emphasized that conditioning occurs because the non-reinforced stimulus that was previously shown in the PE phase is followed by reinforcement. Furthermore, the organism must be exposed to conflicting environmental contingencies in the PE and test phases. This is how LI should be viewed according to the switching model. In stimulus-reinforcement, it is target stimulus that creates conflicting predictions. For developing latent inhibition, subjects have to keep in mind the information they acquired in the PE phase, despite the fact that the stimulus may send signals about reinforcement. Indeed, subjects are aware about the previously preexposed stimulus-no event connections, rather than stimulus-reinforcement connections. This phenomenon is at the heart of the LI effect. If there is disruption of the LI process, it means that subjects are not controlled by the irrelevance of the stimulus-no event contingency but are instead affected

by the current stimulus-reinforcement contingency. Strictly speaking, in the conditioning stage, these subjects show quick responses to a new reinforcement. As a neural mechanism, the switching model plays a significant role in the hippocampus and mesolimbic dopamine system (Weiner, 1990). In other words, the switching model states that the development of LI depends on the subicular input to the nucleus accumbens (NAC) (Weiner, 1990), because NAC through the subiculum receives the biggest input from the hippocampal formation (Kelley and Domesick, 1982; Lopes da Silva et al., 1984; Groenewegen, et al., 1987, 1991, 1994, 1996; Witter et al., 1989; Zahm and Brog, 1992). It was found that the mesolimbic DA has no participation in learning the contingency in the PE phase, but is activated when a stimulus is associated with a novel stimulus or with reinforcement in the conditioning phase.

According to the stimulus-reinforcement contingency in the test phase, the activation of the mesolimbic DA facilitates a quick response time due to enabling quick behavioral and cognitive switching (Robbins and Everitt, 1982; Cools et al., 1984; Oades, 1985; Swerdlow and Koob, 1987; Gelissen and Cools, 1988; Van den Bos and Cools, 1989; Lyon, 1991). The relationship acquired by the CS in the PE phase controls behavior in the conditioning phase as well, because the switching mechanism of the NAC is inhibited by the hippocampus.

Generally speaking (according to the switching model), the final common path through which all manipulations (that disrupt LI) act is the enhanced NAC activation. On the contrary, when NAC DA activity is

blocked, this should protect the LI from the manipulation disruptions, making LI more potent due to blocking the ability to switch.

Further analysis of the switching model suggested that medial raphe-originating serotonergic system influences the switching process. Two sources which influence the switching model have been found. These are the direct serotonergic-dopaminergic interactions at the level of ventral tegmental area/nucleus accumbens, and the indirect influence from passing through the hippocampus that changes the hippocampal input to NAC which in turn disrupts LI. To differentiate between these two channels of influence, it is necessary to determine the area on which serotonergic manipulations act. If we posit that that serotonergic treatments affect LI in the stimulus-no event phase, then the possibility of direct serotonergic-dopaminergic interaction will be eliminated; since the processes involved in the PE phase do not include dopaminergic mechanisms, this would mean the channel of influence arises from a pure serotonergic (hippocampal) effect – indirect source. However, if serotonergic treatments affect latent inhibition in the conditioning stage, it would a mean serotonergic-dopaminergic effect – or direct interaction (Weiner, Feldon, 1997).

Finally, according to the switching model, disruption of latent inhibition is prevented by the activation of the dorsal striatum. In other words, the switching model predicts intact LI after a high dose of amphetamine to the mesolimbic and mesostriatal dopamine systems' differential activation by low and high of its doses. Moreover, the model also indicates that there is a competitive relationship between these two dopamine systems (Bashore et al., 1978; Rebec and Zimmerman,1980;

Groves and Tepper, 1983; Joyce and Iversen, 1984; Porrino et al., 1984; Di Chiara et al., 1991). Thus, by increasing the dorsal striatum activation after a high dose of amphetamines, NAC is blocked, which in turn does not disrupt LI.

Honey and Good (1993), Reilly et al. (1993), and Han et al. (1995), found contradictory results in their study examining the effects of selective excitotoxic lesions of the hippocampus on LI. Honey and Good found that LI was not disrupted by these lesions; on the contrary, LI is potentiated. The authors suggested that axons passing through the hippocampal formation disrupt LI. However, Han et al. discovered that in reality, excitotoxic hippocampal lesions disrupt LI. Aspiration lesion of the ventral hippocampal formation spared LI (Clark et al., 1992) and complete aspiration lesions of the hippocampus disrupted LI (Schmajuk et al., 1994). Furthermore, it is important to mention that Christiansen and Schmajuk found that LI is restored by haloperidol in hippocampal animals (Christiansen and Schmajuk, 1993). Finally, LI disruptions caused by excitotoxic lesions of the medial entorhinal cortex (MEC) and ventral subiculum (vSUB) indicated that the cells in these regions play a significant role in developing the LI (Yee et al., 1995). Systemic treatment with haloperidol revoked the disruptive effect of this lesion. Research found that the serotonergic and cholinergic systems are involved in LI. Rochford, Sen and Quirion (1996) suggested that the cholinergic system was involved in LI. They proposed LI was enhanced when nicotine and nicotinic receptor agonists were given to subjects only in the PE phase or only in the test phase. However, LI was impaired when using nicotinic

antagonists. Despite inconsistencies in the results demonstrated by Joseph et al. (1993) which found that LI is disrupted by nicotine through the activation of DA neurotransmission, Rochford and his colleagues showed that the effect of nicotine depends on the CS exposure duration; if there is longer CS exposure LI will be enhanced, but with short CS preexposure LI will be disrupted.

1.2 Stress and Common Problems in Modern Life

Stress is a widely researched phenomenon, and there are several interpretations of the concept of stress in modern encyclopedias. In psychology, stress is defined as the reaction of the body to all that frightens, irritates or threatens it. In his research, Czech scientist Hans Selye (the first individual to demonstrate the existence of stress) found that stress can be called a nonspecific protective reaction of an organism to unfavorable factors that disturb its quiet existence. To understand the definition of stress, one needs to know the meaning of ‘nonspecific’ word. To illustrate, eating too much sugar will increase blood-sugar level above the normal level, and the body will try to activate chemical reactions that will help to burn the required amount of blood-sugar to decrease it to a normal level (Selye, 1973). This type of reaction is called a nonspecific reaction. This term was coined in 1936, and initially meant “pressure”, “tension” in technical meaning.

Hans Selye, the founder of the theory of stress, claimed: "Stress is life." While we are alive, we will constantly fluctuate between periods of emotional happiness and sadness. Thus, we need to be able to relax, but if emotional stress disappears from our life, it will mean that life is over.

As McEwen (2002) claimed, stress refers to the pressure that life exerts on a person and the way this pressure makes a person feel. It is accepted that how a person perceives stress and stressful stimuli plays a major role in how a person experiences stress. Events and stimuli which are stressful to one person may not be stressful to another. According to McEwen "the human mind is so powerful, the connections between perception and physiological response are so strong, that we can set off the light-or-flight response by just imagining ourselves in a threatening situation" (McEwen, 2002). In his works "Stress without distress" and autobiographic "Stress of my life" (Selye, 1974; Selye, 1977), Selye remarked that "Stress is not what happens to you, but how you react to it."

1.2.1 Stress Pathways

If someone is faced with an immediate threat - for example, an oncoming car – the amygdala, the part of the brain responsible for emotional processing, immediately gets information from human's visual and hearing system. The amygdala interprets these images and sounds and sends a distress signal to the hypothalamus when it perceives danger.

The Sympathetic Adrenal Medullary (SAM) system is the first part of the stress response and 'fast' reaction to sudden stress (Torres et al., 2010) (Figure 2). Essentially, the hypothalamus occasionally plays role as a command center. The Autonomic nervous system helps the hypothalamus communicate with the other parts of the body in response to sudden stressors. It is known that the autonomic nervous center controls breathing, blood pressure, heartbeat and all other involuntary body functions. The sympathetic and the parasympathetic nervous systems are

two components of autonomous nervous system (ANS) (McCorry, 2007). Specifically, the sympathetic nervous system controls the bodily response to a perceived danger and is also responsible for the 'fight or flight' response. 'Fight or Flight' - in another words, adrenaline or noradrenaline - is triggered when the adrenal medulla is stimulated by the sympathetic branch (activated by hypothalamus). How the person physically reacts to threats, harm or attack is called the 'fight or flight' response. When a person experiences a danger or internal worry, his body reacts with an automatic response to either fight or flee from this perceived threat to its survival. Walter Cannon, the individual who coined the "fight or flight" term and pioneered research into the phenomenon, claimed that the response is "well-wired with our brains and designed to save people from bodily harm". He also declared that this response is linked to activity in the hypothalamus, which initiates the firing of nerve cells and prepares our body for fighting or running (Goldstein & Kopin, 2007). The second component of ANS stabilizes homeostasis of the human body and calms the person after a potential threat has dissipated. The parasympathetic nervous system as also responsible for 'rest and digest' functions. When a distress signal is sent by amygdala, the sympathetic nervous system is activated by the hypothalamus and sends signals to the adrenal glands through the autonomic nerves. These glands work to push adrenaline into the bloodstream. Different physiological changes manifest due to a surge of adrenaline. As the heart starts working faster, it pushes blood to the heart and muscles. Furthermore, there is an increase in blood pressure and pulse rate. A person that experiences the changes described above will

breathe faster. Small airways that are located in the lungs open wider to receive as much oxygen as possible in each breath. Alertness increases when extra oxygen is sent to the brain. Vision, hearing, taste and other sensory functions become sharper. At the same time, epinephrine (alternatively for adrenaline) motivates glucose and fats to release their temporary storage into the body. Energy to all the body parts is supplied by the nutrients that flood into the bloodstream. Normally people are not aware of these effects, because the changes happen so quickly. This sequence of reactions is very effective, and the amygdala and hypothalamus start these processes before people have a full cognitive understanding what is actually occurring. Therefore, before realizing what to do, people jump out of the way of oncoming speeding car.

The second part of the stress response system, the HPA axis, is activated by the hypothalamus when the initial burst of adrenaline dissipates. The hypothalamus (H), pituitary gland (P) and adrenal glands (A) are the components of the HPA axis (Stephens and Wand, 2012). With the help of HPA axis, the sympathetic nervous system slows. If a person still faces danger, corticotropin-releasing hormones (CRH) are sent by the hypothalamus to the pituitary gland, which releases adrenocorticotropic hormones (ACTH). ACTH arrives at the adrenal glands, which react by producing cortisol. This keeps the body in a state of alert. When there is no more danger present, the level of cortisol decreases, and the parasympathetic nervous system diminishes the stress reaction (Guillemin, 1978).

1.2.2 Stress and Attention

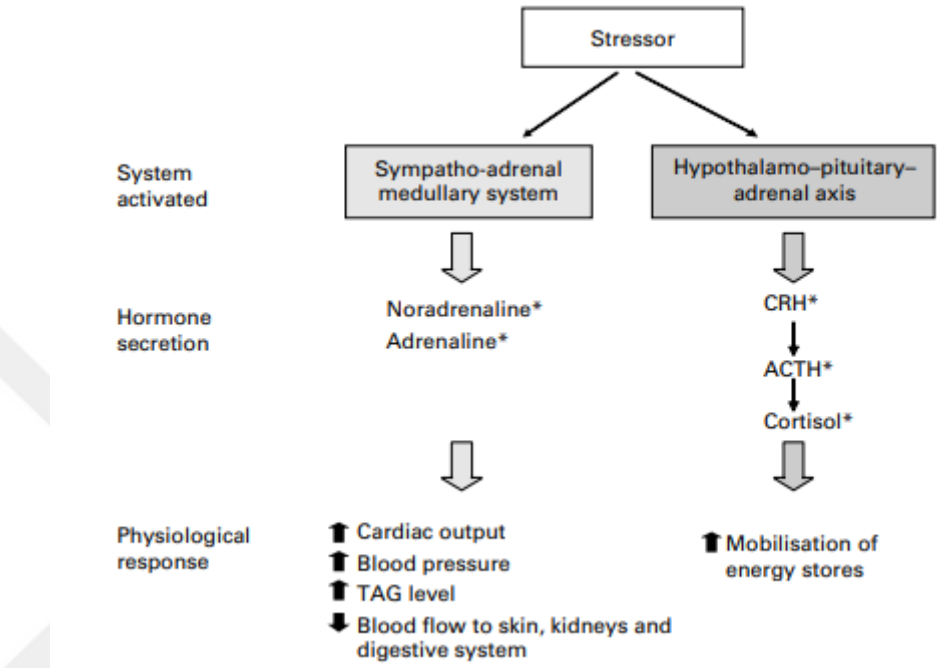

Figure 2. Two components of stress response: Sympatho-adrenal medullary system (SAM) and hypothalamic-pituitary-adrenal (HPA) (Adapted from Torres et al., 2010).

Executive guidance networks largely direct some aspects of human attention, since some essential tasks of everyday life are carried out by them, and therefore the attention may be caused by acute and unexpected environmental stress-factors. For example, if a person is in a wild environment such as a forest, the person's attention may be directed towards the possibility of sighting a snake, thus selective attentional skills will be increased and adaptive towards survival methods. The growing body could find a connection between person's experience of acute stress and the ability of performing controlled attention tasks (Andreotti, 2013). To induce acute stress, Chajut and Algom (2003) had their test subjects perform a few difficult tasks before exposing their subjects to Stroop's selective and divided attention measures (Stroop, 1935). The results demonstrated that after inducing stress, attentional abilities are improved during attention tasks. Teenagers who suffered chronic stress due to a loss of a parent or parents in their early years demonstrated attentiveness biased towards social evaluations and lacked top-down cognitive control (Luecken & Appelhans, 2005). These changes in attention bias can be also be caused by depression or anxiety; individuals suffering these symptoms can suffer an attentional bias towards distinct types of dangerous environmental stimuli which may remain unobserved by an unimpaired individual (Bar-Haim et al., 2007; Mathews and MacLeod, 1994). Stated briefly, on first observation, one may think that the automatic elements of selective attention are influenced by acute stress. However, sometimes, attention bias may be affected due to deficits related to chronic stress. This causes a bias in attention towards environmental

threats that helps to provide the base for affective psychopathology symptoms (Andreotti, 2013).

1.2.3 Adaptation to Stress Across Lifetime

Stress occurs regardless of seasonality but becomes more apparent during hot dry or cold wet weather. Some stress can be important for the body to develop healthily, but long-lasting periods of stress can be overwhelming, with serious toxic consequences. Most commonly, people who experienced trauma during their childhood (for example, from child abuse) can suffer toxic stress (Glaser, 2000). The human brain is sensitive to environmental impacts during formative years when the brain develops quickly. People who have experienced toxic stress in their early life (ELS) may become hyper-sensitive to stressors. As a consequence of having ELS, individuals are more likely to suffer from short or long-term emotional problems that can transform into physical health disorders when the person grows up. Children are faced with different stressful situations as they grow up; during their life, they learn how to manage the stress and its resulting emotions and try to overcome the stress. Selye's general adaptation syndrome (GAS) framework details the three stages of stress which humans experience. It is impossible to remove every single stress from one's life; however, stress can be controlled and must be kept manageable, due to its negative effects on the human body and mind. H. Selye (1956) identified 1) alarm, 2) resistance, 3) exhaustion stages of stress (Figure 3). In the first stage – *alarm*, any negative emotional or mental reaction to stressful stimuli will cause the body to react instantly to

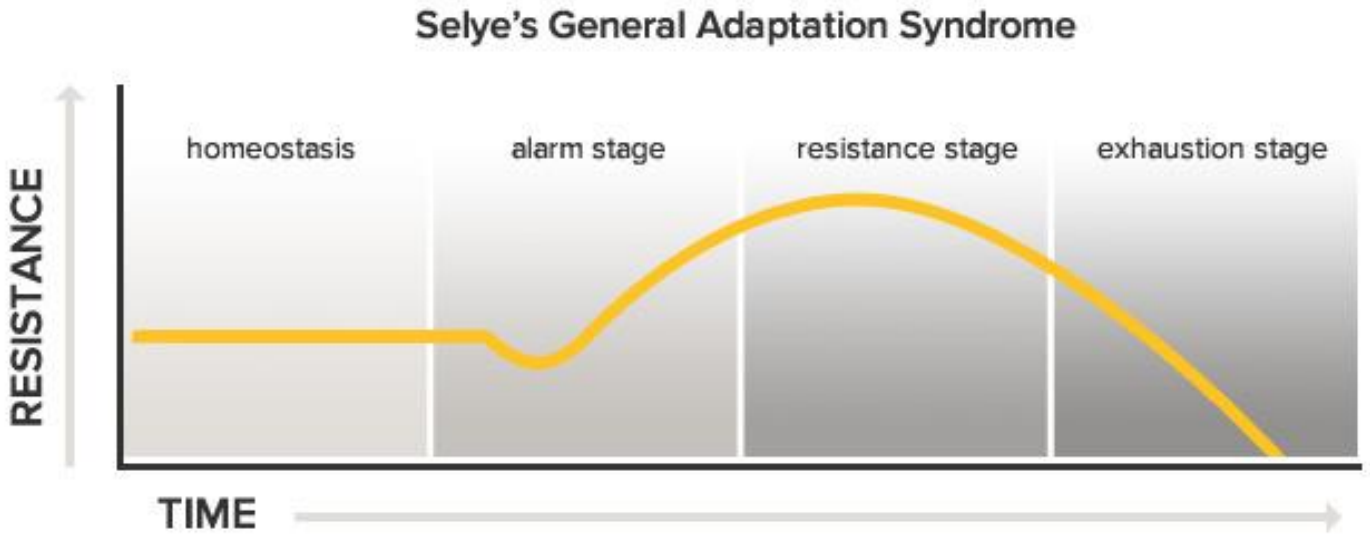

Figure 3. Three stages of stress identified by Hans Selye.

combat the stressor. This ‘fight or flight’ response sends a burst of adrenaline to all important parts of the body: the eyes, heart, lungs etc. The body usually experiences little to no damage when acute (or short-term) stress is experienced. If there is a chronic (or long-term) stress, then affected person’s resistance to illness and disease is lowered. The second stage is class as the *resistance* phase. The body tries to achieve homeostasis in this phase. When stress continues, people generally suffer from problems including insomnia, fatigue, irritability, poor concentration and lower productivity at work. These problems can mount to create even more stress. The last phase is the *exhaustion* phase. Sometimes, after fighting with stress for days or weeks, the human body’s resistance is lowered to such a point that the stressed individual will contract a disease. This could be either a bacterial or viral infection. Chronic stress increases levels of hormones and sebum production, exhausting the epidermis of water and vitamin C. Even if the internal damage that chronic stress causes may not be readily apparent, acne, excess oil and pimples are all external, observable symptoms of stress (Kaminsky, 2016).

1.3 Skin Conductance

When physiologically arousing external or internal stimuli occur, skin instantly becomes a better conductor of electricity. This phenomenon is called skin conductance (SC). Electrodermal activity’ (EDA) is the general term used to refer to any electrical phenomena in the skin. EDA was introduced by Johnson and Lubin (1966); SC is one form of EDA. Skin conductance level (SCL) and skin conductance responses (SCR) are two components of EDA (Figner and Murphy, 2011). The first represents

the baseline category, whereas the second measures the quick increase of SC after the response to external stimuli (Boucsein, 2012). So, the difference between these two phenomena is called amplitude. The change (increase or decrease) in the amplitude values of skin conductance responses is normally used to measure physiological responses to stress in participants. There are 2 easily accessible places in the human body that can be reliably used to measure the SCR; the palms of the hands and soles of the feet (Boucsein, 1992). There is a high density of eccrine sweat glands located in the hands and feet, where the SCR is measured. Furthermore, they are highly responsive to emotional and psychological stimuli, with a measurable response that comes before the appearance of sweat. According to Boucsein (1992) it is important to note that sweating in the eccrine zones differs from sweating in other locations, and it was suggested that eccrine sweating is related to mental processes, not to thermoregulation. To measure the SCR in these places, two electrodes are attached to the palms of the hands in the skin. Following this, the human skin momentarily becomes better at conducting electricity when the arousal level of subjects' increases. Later, responses can be measured and analyzed. Attention and memory are one of the strong predictors of arousal. When a person is at sleep, s/he tends to have lower arousal levels compared to higher arousal levels when a person is awake or doing some mental tasks. Levels of arousal will tend to increase when a person actively engages in a mental task - for example, solving mathematical problems - and then slightly decline.

Toet et al. (2017) conducted an experiment with military personnel. They used the Sing-a-Song Stress Test (SSST) to induce mental stress and a SC as a physiological tool to measure participants' responses to stress (Toet et al., 2017). They hypothesized that male army personnel are more resistant to stress rather than civil participants. The authors used a modified version of SSST, where seven neutral phrases (compared to nine phrases in initial version of SSST) and one stress task were given to the participants, each interchanged with a 60 seconds countdown. Some measures were obtained during the study: heart rate, SCR. In this test, participants had to sit quietly and watch a sequence of seven neutral phrases, each of the same length and structure, about a vacuum cleaner. Each phase was followed by 60 seconds countdown interval. The 8^{th} phrase was presented on the screen as a task, where all participants were asked to start singing a song right after the counter reached zero. The difference between the mean values of 7^{th} phrase and 60 seconds countdown after it (7^{th} phase or baseline hereafter) and 8^{th} phrase and 60 seconds countdown after it (8^{th} phase hereafter) was used as a stress response. Results showed that the 7^{th} phase for all physiological measures was similar for military personnel and civilians, whilst these measures rose during stress task. A significantly higher mean perceived stress level (8^{th} phrase) was observed in the civilian group and a significantly lower mean perceived stress level was observed in the army group. Moreover, the civilian group showed increased heart rates and SCRs to the SSST compared to army participants' heart rates and SCRs. These results

supported the authors' hypothesis that civilians are less resilient to acute stress than military personnel.

Lutscher's (2016) study examined whether a relationship exists between the human's psychological and physiological systems and, if so, whether there is difference between these systems depending on the kind of stressor. Psychological and physiological systems, together with endocrine systems, support homeostasis of the human body (Andrews et al., 2013; Gaab et al., 2005; Ursin and Eriksen, 2004). Lutscher used three tests; a modified version of SSST as a social stressor; a Noise Test as an environmental stressor; and the Beauty Contest Game (BCG) as a cognitive stressor. The author also used the stress questionnaire, where he asked about the subjective stress level of participants' before/during/after the tasks. Responses were measured on 7-point Likert scale. The dependent variables (DV) were the mean amplitude difference between the baseline and stressor and self-reported stress test and the type of stressor was used as the independent variable (IV). Lutcher required participants to sit quietly while measuring the baseline level, and then presented a number of cognitive tasks, for example, asking participants to 'think of things you can find in a kitchen'. The baseline category was measured for 2 minutes immediately before SSST. Afterwards, participants were asked to prepare a song until the counter reached zero and sing it aloud over the following 30 seconds. Participants were also subjected to a noise test consisting of 26 beep sounds with 1000Hz frequency, each lasting 200ms. As it was in SSST, the baseline category was measured for 2 minutes right before the noise test. Finally, a modified version of the Beauty Contest Game was

used (Leder et al., 2015). As usual, 2 minutes were allocated to measure the baseline while participants were asked to sit quietly and only focus on their breathing. Afterwards, participants were shown two tasks on a screen: one task required participants to name objects that they could find in a living room and second required participants to provide animal names that starting with the letter C (Leder et al., 2015). Later, after these tasks, BCG was presented. During the Beauty Contest Game, participants were asked to pick a random number within an interval between 0 and 100. Then the average i.e. the mean of the answers of all participants was calculated and multiplied by 2/3 to calculate the target number. The winner was the individual whose chosen number was the closest to target number (Ho et al., 1998). SCR and self-reported stress were measured while participants were confronted with these tests. Results showed that there was no overall correlation between the mean of the SCR and scores of the self-reported stress test. Only the noise test indicated a significant correlation between psychological and physiological systems, whereas other two stress tasks did not show any significant correlation. Further analysis demonstrated significant differences in mean amplitudes of SCR between the baseline and stressor in the SSST, Noise test and Beauty Contest Game tests. Additionally, t-tests showed non-significant correlations between SSST and Noise tests, between SSST and BCG tests and between Noise and BCG tests. However, based on these results, the author could not provide an answer to the main hypothesis of his study - whether a relationship between the psychological and physiological systems exists. This was because the results he obtained showed no probability of having the

relationship between these two systems according to the type of the stressor.

1.4 LI and Stress Relationship

1.4.1 Research Example

The relationship between LI and stress with animals can be demonstrated in few studies. First, Melo et al. (2003) conducted experiments with sample groups of rats. Using a conditioned emotional response (CER) procedure, the authors examined how provoking chronic mild stress in rats has an effect on LI. There were four groups of rats in the experiment: two control groups and two stressed groups. One of the control groups was non-preexposed control group (NPC) and the second was the preexposed control group (PC). The stressed group was also divided into a non-preexposed stressed group (NPS) and preexposed stressed group (PS). Rats that were in the stressed group were exposed to a chronic mild stress (CMS) for three weeks. Four phases of conditioned emotional response procedure were examined. These phases consisted of tone shock conditioning, retraining, licking response training and testing. Two tone-shock associations were picked for conditioning. These associations witnessed by NPC and NPS showed that stress was not involved with the demonstration of CER. Before the conditioning, a PE phase was conducted by exposing rats to six tones over the period of 30 seconds in two sessions. Rats from the stressed group exhibited depressed learning abilities in the situation when there was prior exposure to the tone. In fact, chronic mild stress caused an increase in LI in rats. Melo and his colleagues (2003) attributed this increase in LI after chronic mild stress to the reduction of

dopamine neurotransmission in the central nervous system. Further analysis revealed that the expression of conditioned emotional response is decreased due to exposure of CMS during the PE condition.

Stressful situations have negative effects not only on humans, but also on animals. If a mother animal is experiencing stress during her pregnancy, the consequences will affect her offspring (Kofman, 2002). The changes will be reflected in brain neurochemistry and in descendants' behavior as well. Experiments showing the effect of prenatal stress in rats and tests of gender difference in LI were done by Bethus et al (2005). According to investigations, prenatal stress has been found to be the main risk factor for developing schizophrenia and depression in her offspring. The changes in the dynamic condition of the dopamine system are associated with schizophrenia and depression. Some other researchers proposed that there can be changes in dopamine activity triggered by prenatal stress. To cause prenatal stress, female rats were exposed to a daily dose of stress in their last week of pregnancy. Female rats were given sucrose for 3 days before the conditioning and tested for LI with a conditioned taste aversion stimulus. After a gestation period, the LI effect was observed as different between genders. Female rats that had no stress showed more LI than male rats with no stress. However, prenatal stress only increased the amount of LI in male rats (Bethus et al., 2005). LI depended on dopaminergic activity that consisted of delayed classical conditioning regarding a stimulus that was not previously signaled about consequences.

1.4.2 Current Study

Even there are many studies of enhanced LI that were previously conducted with young schizophrenics (Cohen et al., 2004), high schizotypy individuals (Granger et el., 2016) or college students (Grant et al., 1948; 1951) and children without pathology (Sokolov and Paramonova, 1956), but no studies were performed with individuals in high stress conditions. Some studies related to stress were done using animal test subjects. For example, Bethus et al. (2005) showed that prenatal stress results in a potentiation of LI in male rats. The enhancement of LI by stress was not observed in the female rats.

As discussed previously, stress can have a significant impact on an organism. If an organism suffers excessive stress, it loses its strength and problem-solving abilities, and more easily catches diseases or presents physical symptoms of stress. Symptoms of stress are not only physiological; stress can also have a significant impact on one's personality. Exams are important part of education but are undoubtedly a considerable source of stress that can seriously affects students' health. Intense mental activity, the load on the same muscles and organs due to prolonged sitting behind books, sleep-wake schedule disorder, and emotional distress leads to placing excessive strain on the nervous system. Headaches, nausea, skin rashes, confusion, panic, fear and nightmares are some of the problems stressed students suffer during exam periods. The night before and immediately prior to an exam, stress can manifest in new ways, for instance as disorders of the digestive system, insomnia, anxiety, excessive perspiration and absent-mindedness. Attention indicates the

direction and focus of human consciousness on certain faculties, which ensures particularly clear reflection. However, if there is too much stress before the exam, this will affect attentive abilities during the exam period. Moreover, stress reinforces the excitatory sweat glands that respond to thermal activity, thus the signal obtained from the SCR plays crucial role on identifying human physiological changes. As LI is related to attention, we may expect stress to affect LI learning.

The latent inhibition effect was first examined via an LI task as described by Evans et al. (2007). Granger et al. (2016) used two within-participants experiments to measure the effect of familiarity on learning where the first-replicated version of the task minimized the alternative effects (learned irrelevance and conditioned inhibition) that also retard learning and the second-modified version of LI task completely removed the contribution of these alternative effects. Thus, it was decided that the modified version of the LI task be used in the current study.

There are two main aims of this study. The first is to identify the LI effect using LI task and second is to demonstrate the effect of stress on LI performance.

To summarize, our first hypothesis states that the reaction time to the PE stimulus will be longer than to the NPE stimulus in both stress and non-stress groups, and hypothesis two predicts that the stress group will exhibit a longer reaction time for PE stimulus and NPE stimulus than the non-stress group will.

CHAPTER II: METHOD

This thesis project aims to investigate the latent inhibition (LI) effect and how LI changes according to the stress. Latent inhibition was examined by LI task and stress was manipulated using The Sing-a-Song Stress Test (SSST). The level of stress manipulation was measured using skin conductance response (SCR) and finger pulse oximetry tests.

2.1 Participants

Eighty-one psychology students (11 males and 70 females) from Izmir University of Economics participated in the experiment in exchange for extra course marks. The age range was 18-42 years old (M = 21.57, SD = 3.51). Before the experimental procedure, a few elimination criteria helped to acquire the most accurate results possible. Participants who marked one of the following from the list were excluded from the study:

- Having any serious visual disabilities,
- Having any psychological disorders,
- Suffering from heart disease,
- Using medication (in the past day),
- Smoking cigarettes (in the last 6-7 hours),
- Drinking alcohol (in the last 6-7 hours).

One participant was excluded from the study due to the above exclusionary criteria.

Furthermore, as a result of excessive perspiration making it difficult to attach electrodes to their palms, three participants were not allowed to start the experiment. Besides, participants who made minimum 7 missed responses or minimum 14 incorrect responses in LI task were removed from the study. According to this, three participants failed to follow this rule.

2.2 Stimuli, Apparatus and Material

2.2.1 Stimuli

All experimental stimuli appeared on a standard desktop computer running Windows 7.

Stress manipulation task. Nine neutral phrases of approximately the same length and structure were selected for the stress manipulation task. The tenth phrase was the following: “When the counter reaches zero again, start singing a song of your own choice aloud without changing your body position.” Since the other nine phrases did not have to elicit stress, neutral phrases about washing machines from the Turkish *Sabah* web-magazine were picked. A translated example was “The washing machine was invented by Alva John Fisher in 1908.” A video with a 60s countdown was used after every phrase.

Latent Inhibition (LI) task. The stimuli for the LI task consisted of capital-letters in Times New Roman-font presented for 1000 milliseconds on a computer screen with a grey background. S and H were the stimulus types, where S was presented as a preexposed (PE) and H as a non-preexposed (NPE) stimuli. The target letter was the letter X and filler-letters were D, M, T and V.

2.2.2 Participant Evaluation and Informed Consent Forms

Participant evaluation forms were given to the participants before the experimental session commenced to assess whether the participants had one of the elimination criteria. This form consisted of questions about participants' psychological well-being (e.g., Do you have any serious visual disorders? Do you have any psychological disorders?) (see Appendix A). The informed consent form apprised participants of the aim of the study and explained participant rights (see Appendix B). Once participants agreed to the terms of the study, they completed and signed the informed consent form.

2.2.3 Stimulus Presentation Program

Stress manipulation and LI tasks were prepared on SuperLab™ (Version: 4.5, Cedrus, Inc.) experiment builder software.

Stress manipulation task. Stress group. The experiment began with the presentation of instructions informing participants about the content of the experiment, without mentioning the stress task. Afterwards, nine neutral phrases followed by a stress task appeared on the screen. The stress task consisted of the presentation of the final phrase demanding that participants sing a song. Every phrase and task were interspersed with a timer counting down from 60 to 0 seconds (Appendix C).

Non-stress group. The same instructions and nine neutral phrases appeared on the screen. The task demanding that the stress group sing a song was replaced by a video not eliciting any stress effect for the non-stress group. The timer counting down from 60 to 0 seconds after each phrase and a video were also shown to the non-stress control group.

Latent Inhibition (LI) Task. In the preexposure phase, filler-letters and PE stimulus S appeared in the center of the screen in a random order and repeatedly appeared on the screen for 3-minute duration. In the test phase, participants were presented with filler-letters, PE, NPE and the target X stimuli, presented in a random order in the center of the screen for 4 minutes. The presentation of each stimulus took 1000 milliseconds. There was also an inter-stimulus interval after each stimulus which lasted for 50 milliseconds.

2.2.4 Data Acquisition System

During the experimental sessions, electrodermal activity was measured using a MP150WSW-G Data Acquisition System, which was connected to the Bionomadix Wireless Pulse and EDA Amplifier BN-PPGED via a Universal Interface Module UIM100C (BIOPAC Systems, Inc.). An isolated digital interface (Model: STP100C; BIOPAC Systems, Inc.) module connecting the MP150 system to the computer running stimulus presentation programs in order to isolate digital inputs and outputs to and from the MP150 system was also used. Disposable snap electrodes (Model: Beybi ECG electrodes) were used in order to measure SCR . There were two pieces of electrodes with isotonic gel that were applied to the thenar and hypothenar eminence of the left hand. Additionally, a finger pulse oximeter device (Contecmed, Model: Cms 50d +) was used for monitoring heart rates.

AcqKnowledge^{TM} (Model: 4.2; BIOPAC Systems, Inc.) software was used for recording and performing offline analysis of the data.

2.3 Procedure

Experiments were conducted in two experimental chambers: the first was used for SSST, and participants were taken to the second chamber immediately after SSST for the LI task. Both experimental sessions were conducted in sound proof chambers and a video camera was placed at the top of the computer monitor to record all sessions (Figure 6).

Before starting the experiment, participants were invited to the participant waiting room and asked to complete the evaluation (Appendix A) and informed consent (Appendix B) forms.

After entering the experimental chamber, preparations for the sessions started. The MP150 system was turned on and the computer running AcqKnowledge^{TM}4.2 was used to record the data and follow participants' responses during the SSST. The Electrodermal Activity (EDA/GSR) BioNomadix® Transmitter wireless device was adjusted to its "ON" position and two pieces of electrodes (Model: Beybi ECG electrodes) were attached, with the aid of isotonic gel, to the thenar and hypothenar eminence of the left hand of participants with the purpose of measuring SCR. Before attaching the electrodes, cotton soaked with plain water was used to clean the skin. The finger pulse oximeter was attached to the right hand of the participants (Figure 7). All participants were required to sit quietly during the experiment, and not move their left hand as EDA is sensitive to body movements; even minor movements may cause motion artifacts. Prior starting SSST, participants were asked whether the room temperature was comfortable for them.

Stress manipulation task. Stress group. In the stress group, one confederate 'participant' who had been picked from participant waiting room also took part in the session (Figure 6). The experiment leader asked real participants to sit in the experimental chamber in front of the monitor one by one and appointed the real participant to start first as his participant number was less than confederate participant's number. After all physiological sensors were set and real participants were ready to start the experiment, the experiment leader explained that individuals would be sitting in turn behind the monitor while their heart rate and SCR were displayed and filmed by a camera. Two monitors, one for the for real participant and one for the confederate 'participant,' were placed back-to-back. Superlab with SSST was installed on the real participant's computer and AcqKnowledge software showing SCR data was installed on the confederate 'participant's' computer (Figure 6). Then, the participants were briefly informed of the content of the SSST and that one trial would entail the task that they needed to carry out. However, they were not told that the task was about singing or stress. After pressing the 'run' button, nine neutral phrases, each lasting 5000 milliseconds, appeared on the screen one by one. A counter counting down from 60 to 0 seconds was shown after every phrase. The 10th phrase entailed the task: "When the counter reaches zero again, start singing a song of your own choice aloud without changing your body position" (Appendix C). Participants sang a song for 15000 milliseconds when the last countdown reached zero. If subjects stopped singing before the end of the period, they were reminded

to continue to sing. The experiment leader stayed in the room together with real and confederate participants until the end of the SSST.

Non-Stress group. Non-Stress group participants were picked from the participant waiting room and accompanied to the experimental chamber. Participants were briefly informed about the content of the SSST and that one trial would require that they watch a video relevant to the research being conducted. Same nine phrases each lasting 5000 milliseconds appeared on the screen. The counter counting from 60 seconds to 0 was also shown after each phrase. The 10^{th} phrase entailed a sentence carrying: 'When the counter reaches zero, watch a video without changing your body position" message. The video lasted for 15000 milliseconds. No confederate 'participant' took part in the non-stress group test.

The used electrodes and pulse oximeter were removed as the SSST finished.

2.3.1 Latent Inhibition (LI) Task

Both stress and non-stress group participants were taken to the second experimental chamber for the LI task once they finished SSST. The task had two phases: preexposure and test phases. Once participants had taken their seats in front of the personal computer, the experiment leader verbally apprised participants of the LI task. In the preexposure phase, participants viewed a sequence of letters appearing on the screen. The task was to count how many times the letter M appeared on the screen. Afterwards, instruction appeared on the screen including detailed information about the preexposure phase. To commence the LI task

participants had to press any keyboard button. Each filler-letters were shown for 15 times and the PE stimulus (S) was shown 20 times during preexposure phase (Table 1, figure 4). The instructions presented to participants in the preexposure phase were as follows:

> "You are going to watch the sequence of letters appearing on the screen. You have to count how many times the letter 'M' appears. This task will last about 3mins. When you will finish this part, you will be given anew instruction. Press any button to start the experiment."

The preexposure phase lasted 3 minutes and was followed by new instructions conveying information about the content of the test phase. Participants were instructed to watch the sequence of letters on the screen and try to predict when the target letter X was going to be shown on the screen. They had to press the space button early in the sequence if they knew when X was going to appear on the screen, or alternatively if they were unable to predict X, they had to press the space button as quickly as possible when they saw X. In the test phase the PE (S) and NPE (new H letter) stimuli were each presented 20 times followed by the presentation of the target stimulus X. X was also preceded 5 times by each filler-letter, totaling 20 presentations of filler-letters and target pairings. Moreover, each filler-letter appeared 11 times, totaling 44 filler-letters on the screen. Instructions presented to participants in the test phase were as follows (Table 1, figure 5):

> "You are going to present the sequence of letters appearing on

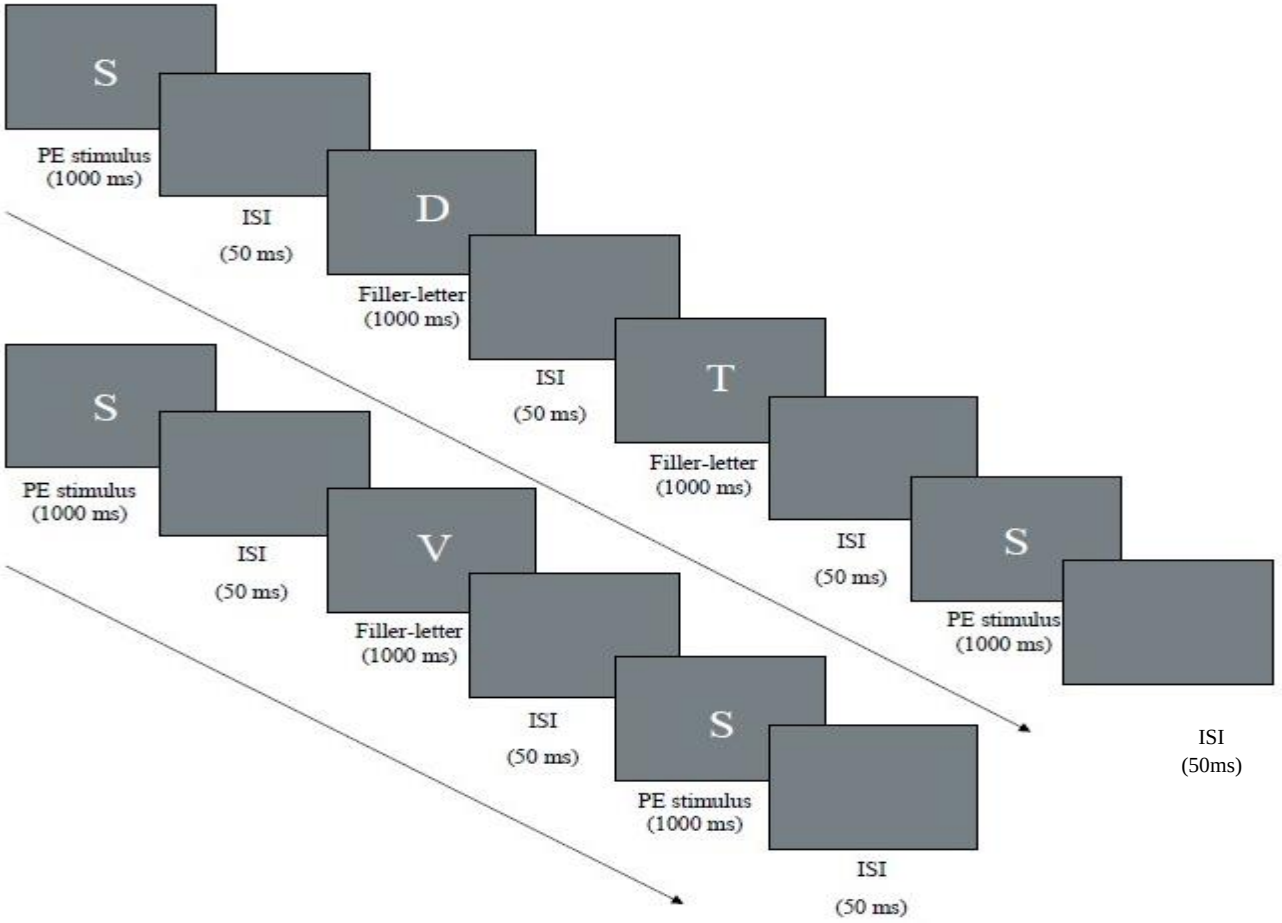

Figure 4. Preexposure stage (S is PE stimulus). Target X was not presented at this stage.

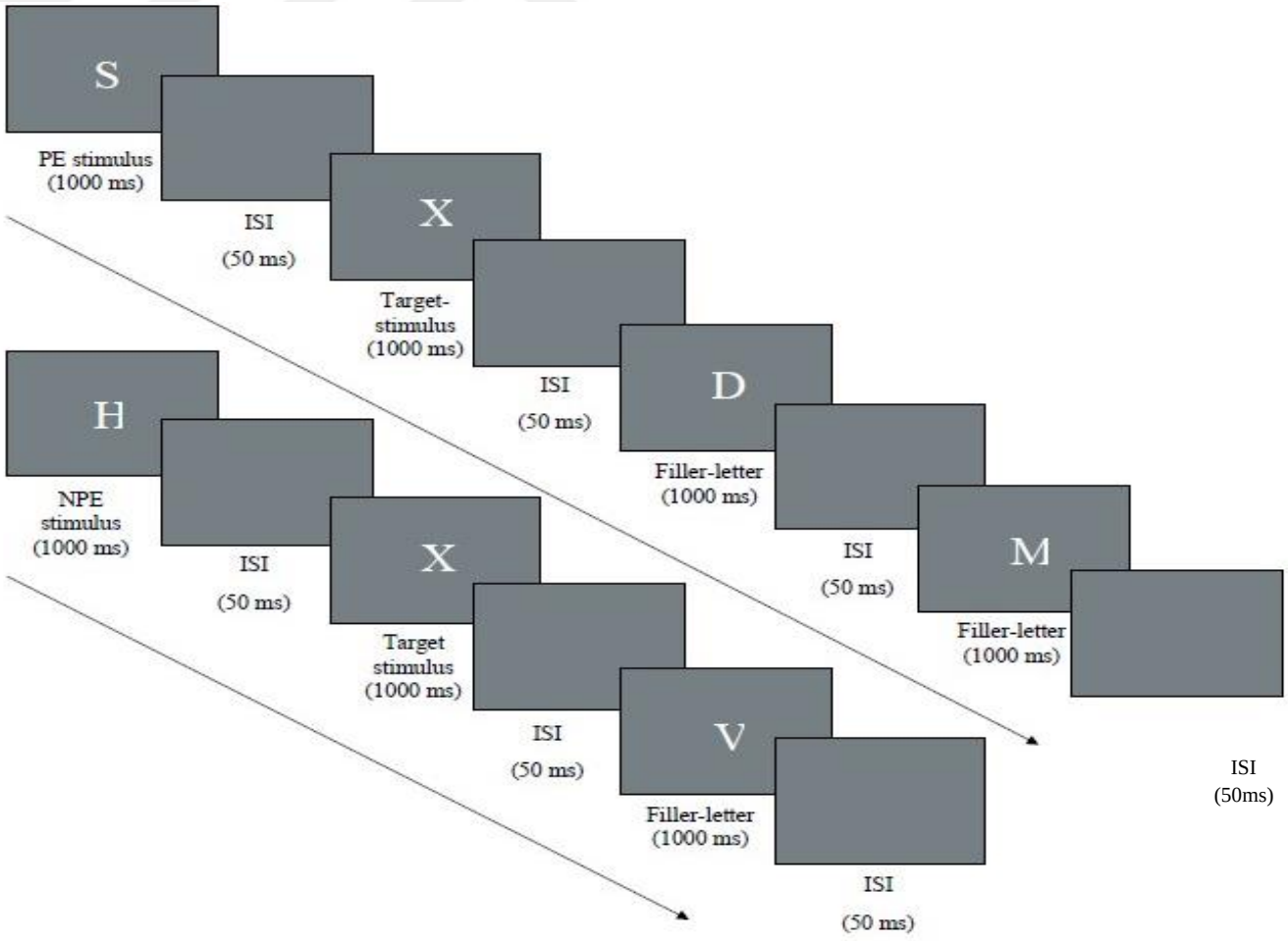

Figure 5. Test Phase: Target X was presented after PE and NPE stimuli, interchanged with random filler letters.

Table 1. Experimental design of LI task

Preexposure Phase	*Test Phase*
PE stimulus:	S --> X (20) PE cued stimulus
S (20)	H --> X (20) NPE cued stimulus
Filler-letters:	
D (15)	D --> X (5) D (11)
M (15)	M --> X (5) M (11)
T (15)	T --> X (5) T (11)
V (15)	V --> X (5) V (11)

the screen. You have to try to predict when a letter 'X' is going to appear. Press space bar early in the sequence if you think you can predict 'X'. Or if you are unable to predict it please press the spacebar as quickly as possible when you see a letter 'X.' There can be more than one rule predicting the letter 'X.' Please try to be as accurate as you can, but do not worry about making mistakes. Press any button if you are ready to start the task."

The LI task lasted 7 mins. After finishing, the participants left the experimental chamber.

2.3.2 Stress Reactivity Task

The main purpose of the SSST was to elicit stress by exposing participants to a stressful situation, in this case, asking participants to sing a song aloud in an unpredictable situation.

During the study, forty-one participants were randomly assigned to stress test. After physiological sensors were applied, the experiment leader ran SSST. Nine neutral phrases about washing machines were selected and presented to the participants. Each phrase was shown on the screen for 5000 milliseconds, interchanged by the counter counting from 60 to 0 seconds. Presented nine phrases were neutral phrases, without eliciting any arousal effects, hence they considered to be baseline. For the current study, only the 9^{th} phrase and a 1-minute countdown after it ('9^{th} phrase' thereafter) were taken as a baseline and used for further analysis. During the experimental procedure, the pulse oximeter was checked 4 times: 1) at the beginning of 9^{th} phrase (baseline), 2) in the middle of 9^{th} phrase (baseline), 3) in the middle of the 1-minute countdown after 10^{th} phrase

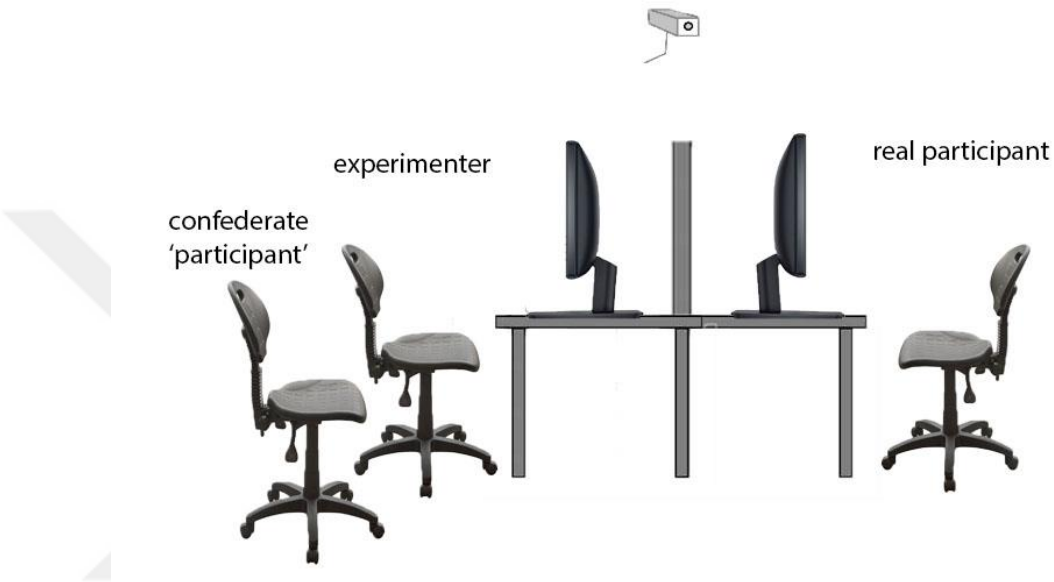

Figure 6. Experimental chamber for SSST

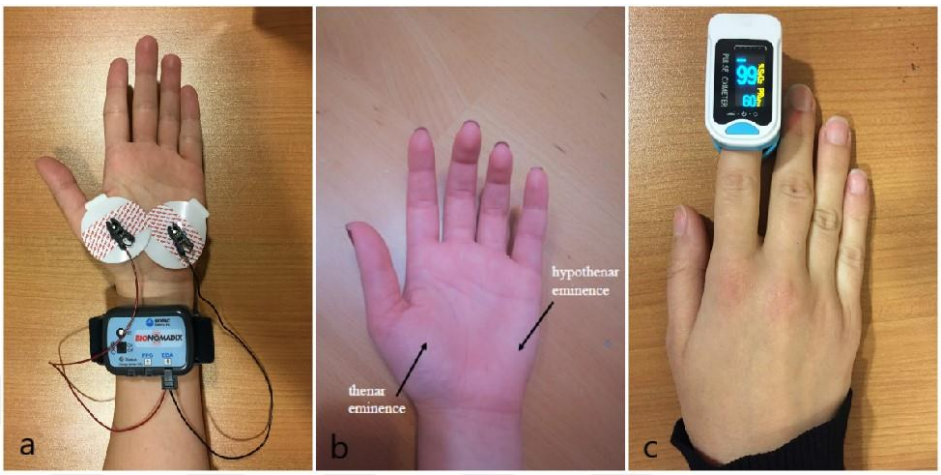

Figure 7. a) BioNomadix® Transmitter wireless is set to On position and two electrodes were applied to the thenar and hypothenar eminence of the left hand for measuring skin conductance response, b) Location of thenar and hypothenar eminence in palm of a hand, c) finger Pulse Oximeter measuring heart rates is applied to the index finger of the right hand.

(a task required to sing) (‘10th phrase’ thereafter), 4) at the end of the 10th phrase when singing was finished. The differences in heart rates between the 9th and 10th phrases as well as differences in skin conductance between the 9th and 10th phrases were computed. When the counter reached zero for the last time after 10th phrase, the “Please start singing” phrase appeared and remained on the screen for 15000 milliseconds. SSST finished once the participants had finished the singing task.

Non-Stress group. The non-stress group went through the same steps, but with a different 10th phrase. The same neutral nine phrases interchanged with 60 seconds counter appeared on the screen. Participants were asked to sit silently and watch a video when the counter reached zero. The video was about nature, was not designed to elicit any arousals and stress, and lasted 15000 milliseconds.

2.4 Preparation of Skin Conductance Data for Analysis

Data acquisition was performed by means of MP150 systems and recorded with Acqknowledge™ 4.2 during experimental sessions. Figure 9 demonstrates recorded data of EDA, and how SCR changes according to each phrase. Responses given to every phrase on SuperLab™ can be seen in figure 8. Figure 9 shows how the responses differ during the 9th and 10th phrase. Skin conductance measures rose sharply right after participants saw the task instruction (Figure 9). In contrast, for the non-stress group, there was little difference between the skin conductance response measured over the 9th and 10th phrases. When the personal skin conductance response to the specific stimulus was measured, response levels were determined as the difference from the baseline to peak (amplitude, in microsiemens, μs) of

the first response following the stimulus onset. For the 9th and 10th phrases, the base and the peak of the waveform has to be inside the time interval that corresponds to these trials and has to have an amplitude greater than minimum value of SCR criterion – 0.02 μs. Figure 9 shows the whole data recording of the participant in stress group. Top channel is EDA channel, whereas middle and bottom channels (digital input) are the channels showing the start and end of the time interval for 9th and for 10th phrases. The calculations and comparisons were made using base and peak values in these time intervals. The line at the bottom characterizes time when Acqknowledge™ was turned on before SSST and turned off after SSST.

2.4.1 Calculation of Acquisition Score

Acquisition scores were calculated by using SCRs between 9th and 10th phrases before conducting further analysis of the data. In the stress group, higher acquisition scores during the 10th phrase compared to the 9th phrase indicated that participants had acquired stress during SSST. Primarily, the response amplitude (Figure 10) was calculated by subtracting the base microsiemens value from the peak microsiemens value for the 9th and 10th phrase. Subsequently, due to the probability of having a negatively skewed distribution, square root transformation was applied to all values calculated in the previous step (Boucsein, 2012). In the last step, each transformed value of the 10th phrase was divided by the transformed value of the 9th phrase. Obtained values were used for further analyses.

2.5 Scoring of LI Task

Reaction times (RT) were recorded only in the test phase. The RT from the onset of the PE and NPE stimulus that preceded X was used

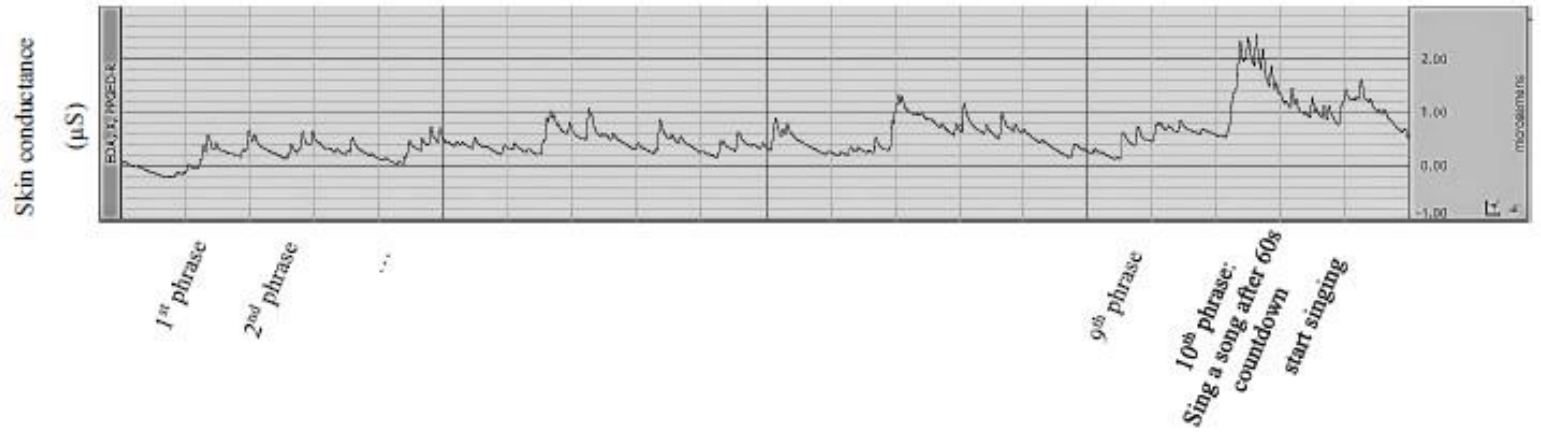

Figure 8. Skin conductance of a participant across the whole experiment.

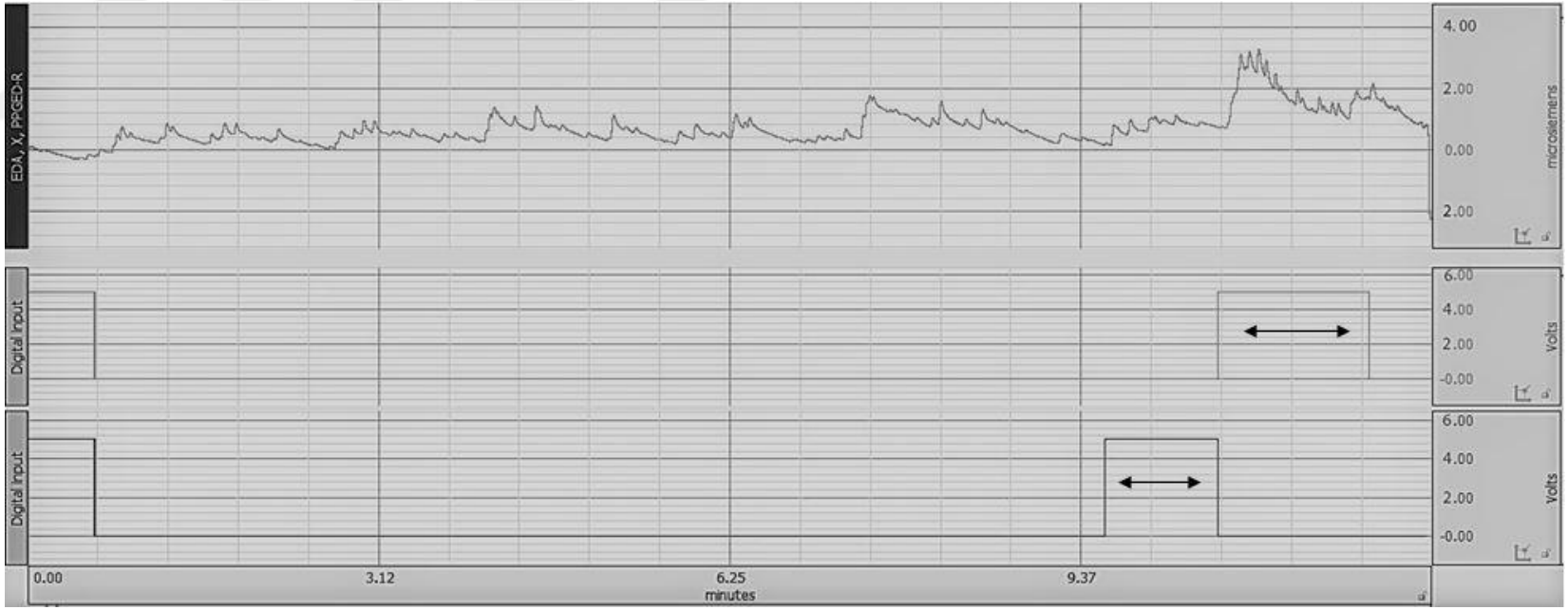

Figure 9. Sample of recorded data of participant in stress group. Arrows show 9th and 10th phrases, respectively.

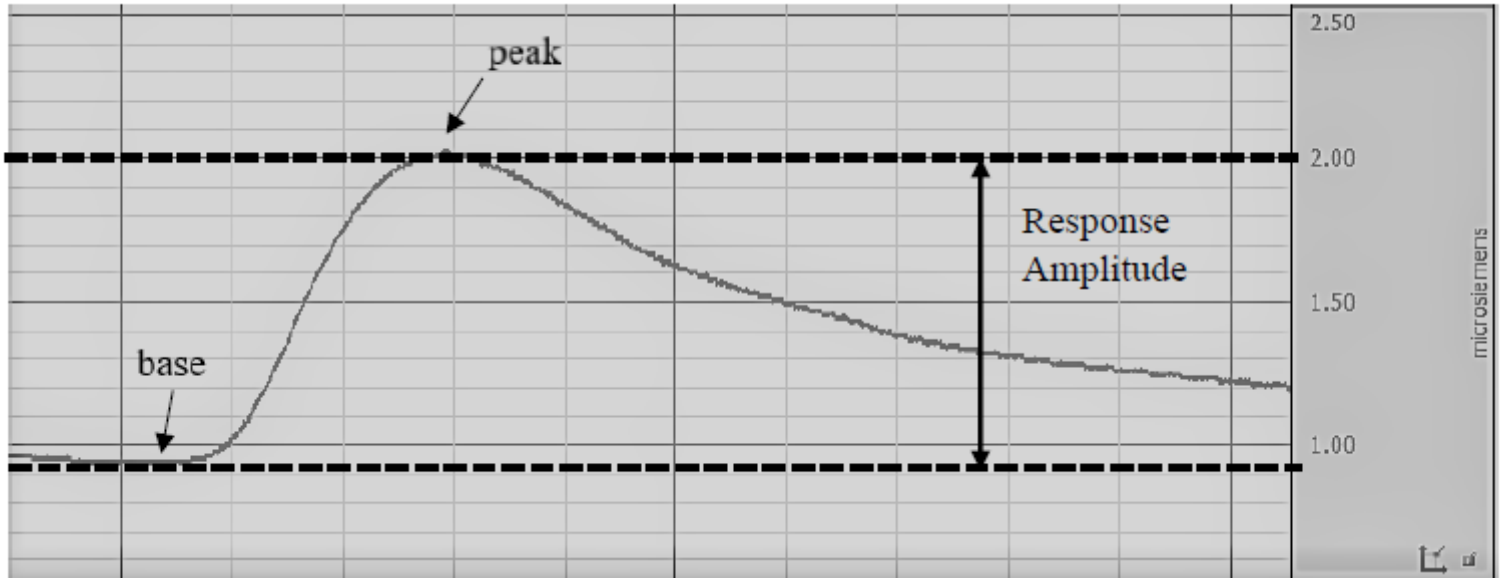

Figure 10. Graphic illustration of single response, its base and peak, derived from EDA.

for further analysis. The mean reaction time of all 20 PE and 20 NPE stimuli was calculated.

2.6 Research Design

A 2 (Type of Stimulus: PE and NPE) x 2 (Conditions: Stress and Non-Stress Group) Mixed design ANOVA was conducted for the research. Reaction time to the PE and NPE stimuli during the test phase was recorded as dependent variable. Stress and non-stress groups were independent variables.

CHAPTER III: RESULTS

Results of the stress-task analysis and LI task analysis will be reported in this chapter. Firstly, in order to see whether there was a difference between mean heart rates of stress group of participants and non-stress group of participants between 9th phrase and 10th phrase, 2 (Condition: Stress and Non-Stress Group) *x* 2 (Time of measurement: 9th phrase and 10th phrase) mixed design ANOVA was conducted. Moreover, in order to see whether there was a difference between mean SCRs of stress group of participants and non-stress group of participants, an independent t-test was conducted. Lastly, in order to see whether there was a difference between mean reaction time of stress group participants and non-stress group of participants between PE and NPE stimuli, 2 (Condition: Stress and Non-Stress Group) *x* 2 (Type of stimulus: PE and NPE) mixed design ANOVA was conducted.

3.1 Physiological Results

3.1.1 Heart Rate Analysis

In order to see whether there was a difference between mean heart rates of stress group of participants and non-stress group of participants in 9th phrase and 10th phrase, a 2 (Condition: Stress and Non-Stress Group) *x* 2

(Time of measurement: 9th phrase and 10th phrase) mixed design ANOVA was conducted. Results of the analysis revealed that there was significant main effect of condition, $F(1,79) = 7.79$, $p < .05$, partial $\eta^2 = .09$. Mean heart rate of stress group participants ($M = 93.17$, $SE = 1.92$) was higher than mean heart rate of non-stress group participants ($M = 85.76$, $SE = 1.83$) (Figure 11). Moreover, results of the analysis showed that there was a significant main effect of time of measurement, $F(1, 79) = 127.03$, $p < .05$, partial $\eta^2 = .62$. Mean heart rate of participants during 10th phrase ($M = 94.94$, $SE = 1.83$) was significantly higher than during 9th phrase ($M = 84.09$, $SE = 1.34$) (Figure 12). Additionally, condition and time interaction effect was significant, $F(1, 79) = 155.13$, $p < .05$, partial $\eta^2 = .66$. The interaction graph showed that during the 9th phrase mean heart rate of the stress group participants ($M = 81.90$, $SE = 1.79$) was not significantly different from mean heart rate of the non-stress group participants ($M = 86.33$, $SE = 1.94$). However, during 10th phrase, mean heart rate of the stress group participants ($M = 104.44$, $SE = 2.39$) was significantly higher than mean heart rate of the non-stress group participants ($M = 85.20$, $SE = 1.77$). Simple effect analysis showed that during 9th phrase, there was no significant difference between mean heart rate of stress group and non-stress group participants, $F(1, 79) = 2.81$, $p > .05$. On the other hand, during 10th phrase, there was a significant difference between mean heart rate of stress

and non-stress group participants, $F(1, 79) = 41.46$, $p < .05$, $r = ..59$ (Figure 14).

3.1.2 SCR Analysis

Acquisition scores were calculated by using SCRs between 9th and 10th phrases. Firstly, response amplitude was calculated by subtracting the base microsiemens value from the peak microsiemens value for both 9th and 10th phrases. Secondly, due to the probability of having a negatively skewed distribution, square root transformation was applied to all values calculated in the previous step (Boucsein, 2012). In the last step, each transformed value of the 10th phrase was divided to the transformed value of the 9th phrase and weighted SCRs were obtained.

In order to see whether there was a difference between mean weighted SCRs of stress group of participants and non-stress group of participants, an independent *t*-test was conducted. The results revealed that stress group participants showed higher weighted SCRs ($M = .71$, $SE = .02$) than participants in non-stress group ($M = .49$, $SE = .03$). This difference was significant $t(79) = 6.41$, $p < .05$, and it did represent large effect, $r = .59$.

3.2 Latent Inhibition Analysis

In order to see whether there was a difference between mean reaction time of stress group participants and non-stress group of participants between PE and NPE stimuli, a 2 (Condition: Stress and Non-Stress Group)

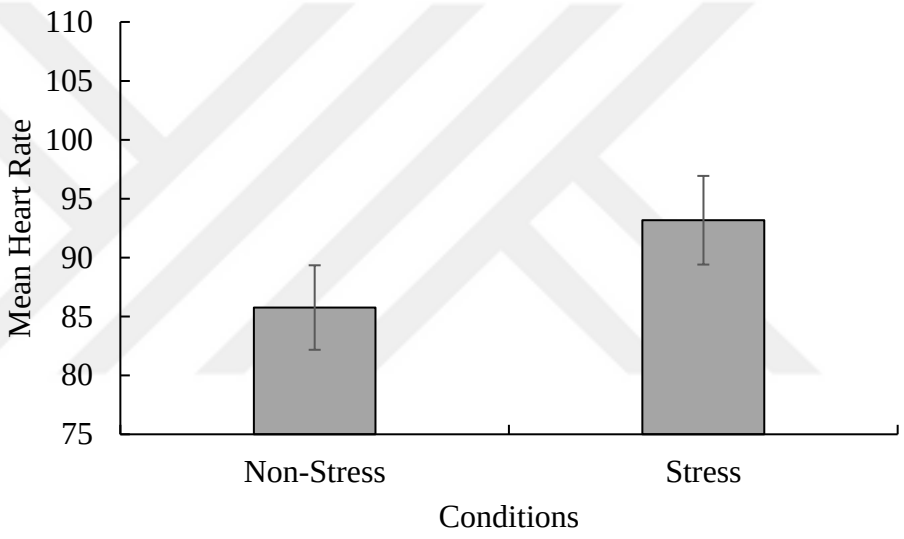

Figure 11. Mean (with 95% CI) heart rate of non-stress and stress group participants.

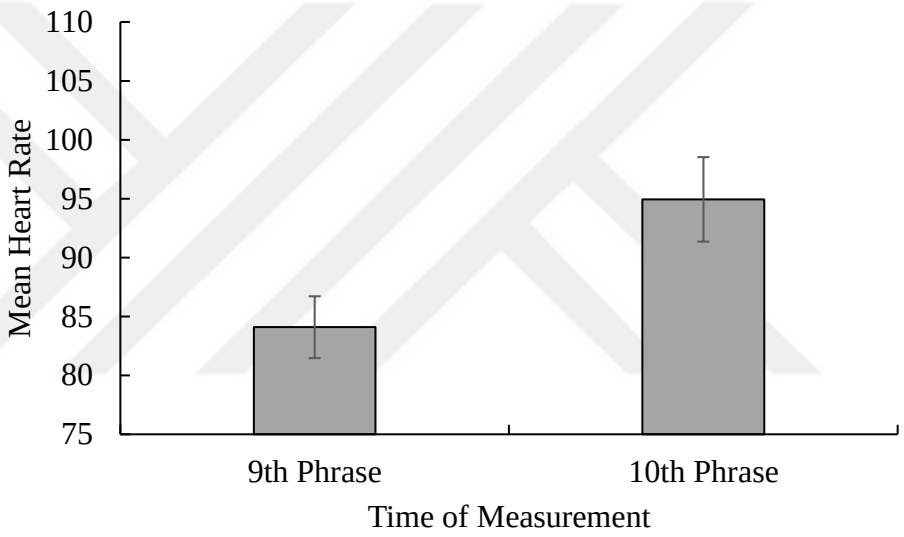

Figure 12. Mean (with 95% CI) heart rate of participants during 9th and 10th phrases.

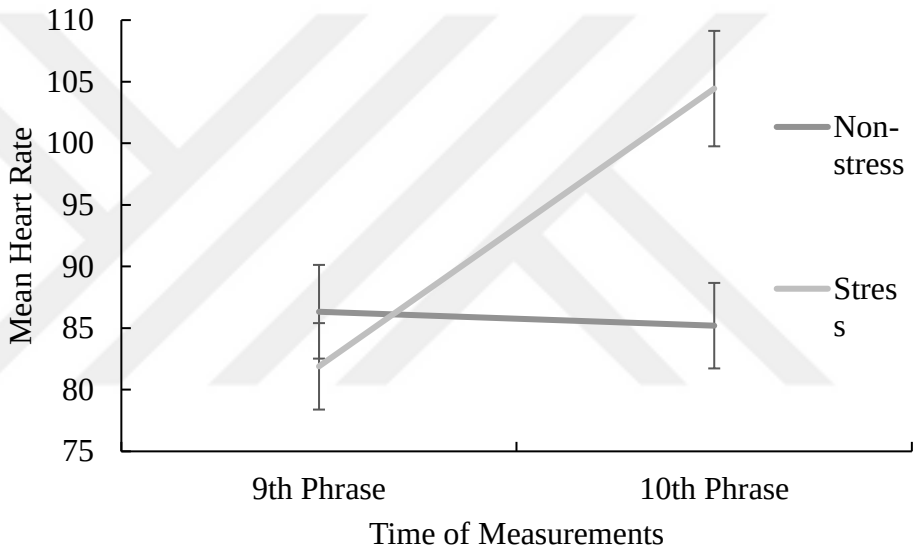

Figure 13. Mean (with 95% CI) heart rate of participants during 9th and 10th phrases in non-stress and stress conditions.

x 2 (Type of stimulus: PE and NPE) mixed design ANOVA was conducted. The results revealed that there was a significant main effect of condition, $F(1, 79) = 19.57$, $p < .05$, partial $\eta^2 = .20$. Mean reaction time of stress group participants ($M = 1290.07$, $SE = 29.97$) was significantly higher than mean reaction time of non-stress group participants ($M = 1120.52$, $SE = 23.71$) (Figure 15). Additionally, results of the analysis showed that there was a significant main effect of type of stimulus, $F(1, 79) = 68.18$, $p < .05$, partial $\eta^2 = .46$. Mean reaction time for PE stimulus ($M = 1315.05$, $SE = 13.47$) was higher than mean reaction time for NPE stimulus ($M = 1097.64$, $SE = 13.47$) (Figure 16). Furthermore, condition and type of stimulus interaction effect was significant, $F(1, 79) = 4.29$, $p < .05$, partial $\eta^2 = .05$. The interaction graph showed that the mean reaction time for PE stimulus in stress group participants ($M = 1371.77$, $SE = 20.25$) was significantly higher from the mean reaction time for PE stimulus in non-stress group participants ($M = 1256.90$, $SE = 16.86$), $F(1, 79) = 5.62$, $p < .05$, $r = .26$. Moreover, reaction time for NPE stimulus in stress group participants ($M = 1208.37$, $SE = 20.25$) was also significantly higher from mean reaction time for NPE stimulus in non-stress group participants ($M = 984.14$, $SE = 16.86$), $F(1, 79) = 25.33$, $p < .05$, $r = .49$. Additionally, mean reaction time for PE stimulus in non-stress group ($M = 1256.90$, $SE = 16.86$) was significantly higher than mean reaction time for NPE in non-stress group ($M = 984.14$, $SE = 16.86$), $F(1, 79) = 52.67$, $p < .05$, $r = .63$. Furthermore, mean reaction time for PE

Figure 14. Mean (with 95% CI) SCRs in non-stress and stress conditions.

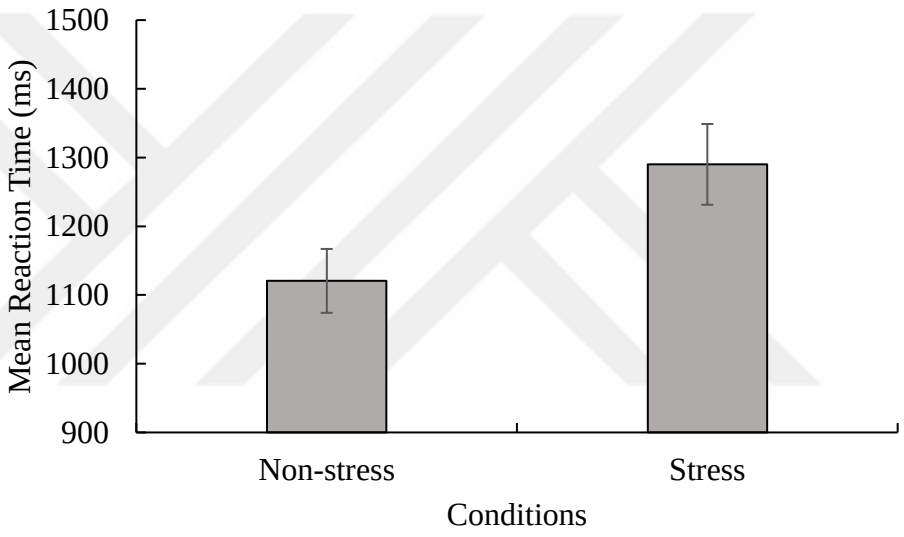

Figure 15. Mean (with 95% CI) of the reaction time in non-stress and stress conditions.

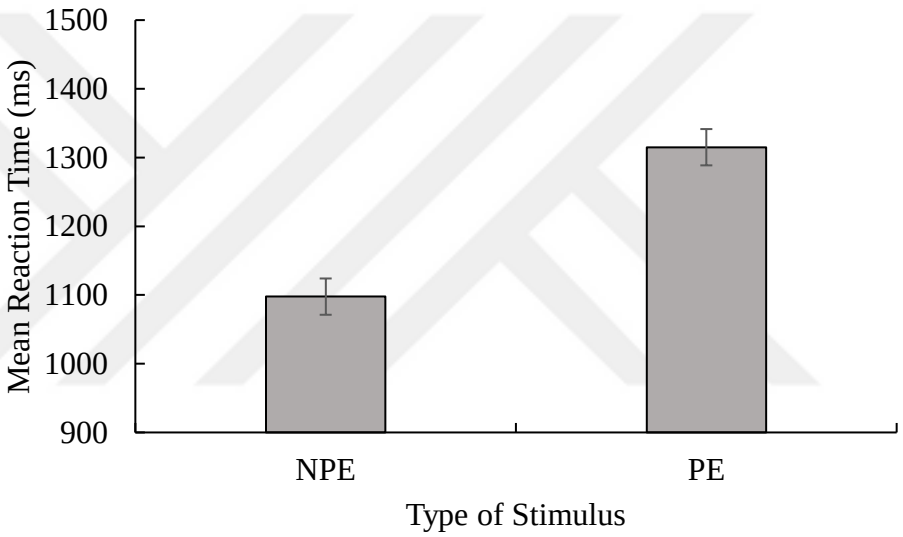

Figure 16. Mean (with 95% CI) reaction time to NPE and PE stimuli.

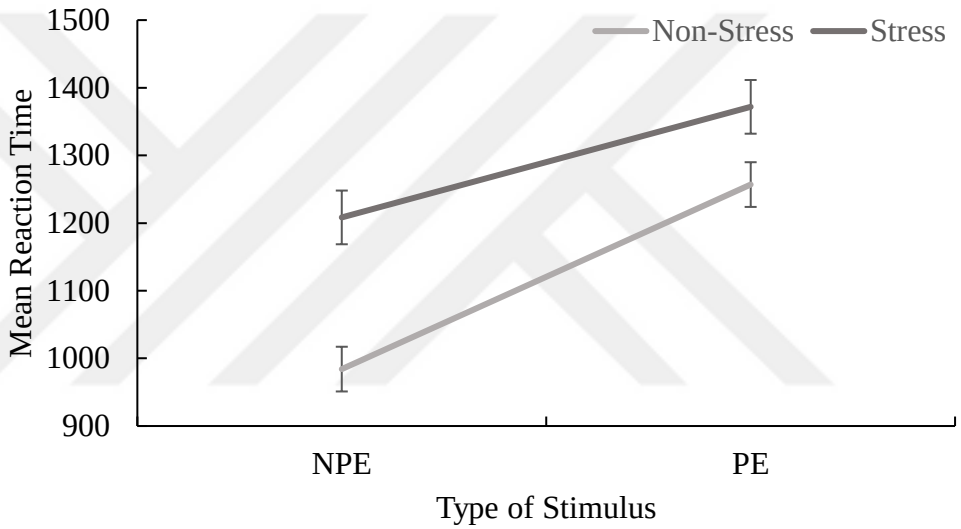

Figure 17. Mean (with 95% CI) reaction time of participants to NPE and PE stimuli in non-stress and stress conditions.

stimulus in stress group (M = 1371.78, SE = 20.25) was significantly higher than mean reaction time for NPE in stress group (M = 1208.37, SE = 20.25), $F(1, 79) = 19.38$, $p < .05$, $r = .44$ (Figure 17).

CHAPTER IV: DISCUSSION

With the current study the relations between LI and stress were examined. Browsing the literature, experiments showing the relationship between LI and stress were not found in human sample, however stress is found to bias attention which plays important role in LI, therefore it was aimed to get unique results at the end of the study. Based on this hypothesis we aimed to demonstrate the LI effect, or in other words, to show whether reaction time for NPE stimulus will be shorter than the reaction time for PE stimulus for stress and non-stress groups. Moreover, we expected that reaction time for stress group (for both PE and NPE stimuli) will be longer than reaction time for non-stress group (for both PE and NPE stimuli). For this purpose, LI task was used as the first experimental session to demonstrate LI, and Sing-a-Song Stress Test – for inducing mental stress in participants.

The first experiment – SSST – was used to induce the mental stress in participants. During this test, participants were presented with nine neutral phrases on the screen. There were 1-minute counter after each neutral phrase. The final 10^{th} phrase asked participants to sing a song out

loud when the 1-minute interval reached zero. Skin conductance and heart rates were measured during SSST. These measures were found to be significantly higher during the sing-a-song phrase than during the last neutral phrase. Higher heart rate after the stress was found in the study of Schubert et al. (2009). They conducted an experiment where the effect of stress on heart rate was examined. Participants were told to prepare and present a speech about some certain topic. They were also informed that their speech will be videotaped and will be rated by experts. 3 minutes of preparation time were given to participants, after which they spoke for 3 minutes. The results showed that mean heart rate increased significantly in response to the speech task. One more study investigated the difference between heart rates of students during lecture period, written examination period and period when graded exam papers were returned to students (Elwess and Vogt, 2005). All three activities were held on different days. They found that heart rates of students on exam day were 35% higher than heart rate of students during lecture day. Moreover, heart rates when graded examinations were returned to the students were 26% higher than heart rates during lecture. Increased heart rates were the indicators of stress, appeared after exam-induced anxiety.

Increase of SCRs while exposing participants to the mental stress was demonstrated by Toet et al. (2017). Civil and army participants were exposed to SSST, while SCRs for both groups were measured. The

difference between the mean values of last neutral phrase and stress task asking participants to sing a song was calculated as stress response. Same baseline level of SCR was observed in both army and civil group of participants, whereas significant increase of SCR was observed after the stressor.

During second experiment of the study LI effect was demonstrated by using LI task. In preexposed phase PE stimulus alongside with four filler-letters were presented with random order. In test phase same stimuli previously presented in preexposed phase and additionally a novel (NPE) stimulus were presented in random order as well. As it was expected, there was a decrease in learning of PE stimulus and target stimulus associations caused by prior exposure of the PE stimulus in preexposed phase for both stress and non-stress groups, or in other words, the reaction time to the NPE stimulus was shorter than reaction time to PE stimulus in test phase, which confirmed the hypothesis one. A few researchers stated that LI can be confounded by side effects that also retard the learning (Granger et al., 2016). These side effects are learned irrelevance and conditioned inhibition. They conducted LI experiment, where a zero contribution of these side effects was found. In LI task used in their study target stimulus was not presented during preexposure phase, therefore conditioned inhibition was not the topic of their research. Conditioned inhibition could be contributed if there would be an expectation of the target stimulus, however it did not

appear during PE phase. Moreover, it was difficult to explain the results in terms of learned irrelevance, because in the PE phase participants had to process each letter, determine whether it was M or not and count frequency of letter M (Evans et al., 2007). Despite many studies demonstrating the LI effect, the reason behind this phenomenon still requires to be clarified. Bouton (1993), Lubow and Gewirtz (1995) stated that LI effect appears because of the competition between the received information that humans or animals get during the preexposure and associations made up during the test phase, however it still needs to have another look at analysis.

As animals and humans are similar in relevant features, thus study on animal models can be used to understand human's behavior. Lubow and Moore (1959) constructed set-up for sheep and goats. In preexposure phase light or turning rotor in random order were presented as a CS. In test phase light and the rotor each were paired with the mild shock (US) presented to the right foreleg. Repeatedly presentation of CS-US, made an animal an anticipatory leg flexion (CR) during only CS presentation. Thus, CR to the PE and NPE stimuli was generated. Conditioning to the new CS was found to be significantly faster than to the PE stimulus. Authors on their second experiments obtained equivalent results by placing CS and US on opposite side of the animal (Lubow and Moore,1959, Experiment 2). Once more, conditioning to the PE stimulus was found to be poorer than to the new stimulus.

Rascle et al. (2001) conducted a between participants design where chronic schizophrenia patients who had PE stimulus showed slower learning in comparison to control group of patients, resulting in an enhancement of LI. Moreover, a disrupted LI was observed in acute schizophrenic patients, and enhanced LI in chronic schizophrenic patients.

Collected data from current study showed that both group of participants (stress and non-stress groups) showed different results, suggesting that the stress manipulation did interfere with learning. Simply saying, it took longer time to learn the associations of PE and NPE stimuli for the stress group of participants than non-stress group, meaning that induction of stress enhanced the LI process in stress group, confirming the second hypothesis. Participants in stress group had higher reaction times than participants in non-stress group. More precisely, participants in stress group had longer reaction time for PE stimulus than participants in non-stress group (RT for PE). Additionally, participants in stress group had longer reaction time for NPE stimulus than participants in non-stress group (RT for NPE). Besides, reaction time for PE stimulus in non-stress group was significantly longer than reaction time for NPE in non-stress group. Furthermore, reaction time for PE stimulus in stress group was significantly longer than reaction time for NPE in stress group. Although, as shown in Figure 20, it is supposed that stress somehow blocked the latent inhibition in stress group. According to the figure 20, the stress group line rises slightly,

whereas the intensive rise of the non-stress line is observed. However, this phenomenon cannot be explained at this moment and can be investigated in the future.

In summary, even though we got unexpected results regarding the reaction time to the preexposed stimulus between stress and non-stress groups (the difference of non-preexposed stimulus between stress and non-stress groups became less than difference of preexposed stimulus between stress and non-preexposed groups), the current study showed a significant increase in latent inhibition after inducing mental stress. Limitations and future studies apparently can help to understand the source of this finding.

4.1 Limitations and Future Studies

Having even more number of participants could probably give us different results regarding the results discussed in the last paragraph. In the current study unequal number of males and females were used, thus by equalizing them the difference between males and females can be investigated again. Moreover, aging has significant impact on attention, therefore having only investigated participants with the same age group would be important criteria for latent inhibition in the future studies.

Appendix A

"Participant Evaluation Form"

KATILIMCI BİLGİ FORMU

İSİM SOYİSİM:	OKUL:
CİNSİYET: NUMARASI:	TELEFON
YAŞ:	
MESLEK:	e-MAIL:

1. Herhangi ciddi bir görme bozukluğunuz var mı?

   ☐Evet ☐Hayır

2. Her hangi bir psikoloji bozukluğunuz var mı?

   ☐Evet, hangisi_____, ☐Hayır

3. Kalp rahatsızlığınız var mı?

   ☐Evet ☐Hayır

4. Herhangi bir psikoaktif ilaç kullanıyor musunuz?

   ☐Evet ☐Hayır

5. Sigara kullanıyor musunuz?

☐Evet, bugün ___ saat once kullandım**,** ☐dün veya dünden daha önce,

☐sigara kullanmıyorum

6. En son ne zaman kahve içtiniz?

☐Bugün ___ saat önce içtim**,** ☐dün veya dünden daha önce, ☐kahve

içmiyorum.

7. En son ne zaman alkol tükettiniz?

☐Bugün ___ saat önce tükettim**,** ☐dün veya dünden daha önce, ☐alkol

tüketmiyorum.

8. Herhangi bir spor yapıyor musunuz?

☐Evet, hangisi_____, ☐Hayır

9. Son bir hafta icerisinde stresli bir olaya maruz kaldınız mı?

☐ Evetse, düzeyi, 1_____2_____3_____4_____5 ☐Hayır

Deney önceki stress düzeyiniz nedir?

0____10____20____30____40___50____60____70___80____90____100

Deney zamanı stress düzeyiniz nedir?

0____10____20____30____40___50____60____70___80____90____100

Appendix B

"Informed Consent Form"

Katılımcı №: ___

KATILIMCI BİLGİLENDİRME FORMU

Bu çalışmanın amacı, ekranda sunulan harf dizisini izleyerek, 'X' harfinin gelişini tahmin edebilen kuralları öğrenmek ve `X`in ne zaman sunulacağını önceden tahmin etmektir.

Çalışma kapsamında katılımcılardan elde edilen veriler isim kullanılmaksızın analizlere dahil edilecektir. Katılımınız araştırma hipotezinin test edilmesi ve yukarıda açıklanan amaçlar doğrultusunda literatüre sağlayacağı katkılar bakımından oldukça önemlidir. Ayrıca katılımınızın psikoloji alanın gelişmesi açısından da bir takım faydaları bulunmaktadır.

Çalışmaya katılmanız tamamen kendi isteğinize 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.

Okudum, kabul ediyorum

İmza_____

Katılımcı №: ___

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:

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

Araştırmacının Telefon Numarası:

.....

Çalışmanın amacı ve içeriği hakkında açıklamaların yer aldığı "Katılımcı Bilgilendirme Formu"nu 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 C

Instructions, neutral phrases and the duration presented to participants in Sing-a Song Stress test.

Number of phrase	Instructions and Phrases	Duration
Instruction	Sit as still as possible and silently read the messages that appear on the monitor, interchanged by a counter counting down from 60 to 0s.	30s
Neutral 1st	Washing machine was invented by Alva John Fisher in 1908.	5s
Neutral 2nd	Fisher called it Thor when he invented it.	5s
Neutral 3rd	Dirty laundry was putting into a metal drum placed horizontally inside the machine.	5s
Neutral 4th	The drum was rotated by means of electricity and the laundry was constantly being cleaned by contact with the water during the movement.	5s
Neutral 5th	But the first washing machine with drying function was invented in 1924.	5s
Neutral 6th	Starting from 1940 automatic washing machines were ready to serve housewives.	5s
Neutral 7th	However fully automatic	5s

	machines had to wait 1951 year to enter the markets in Germany.	
Neutral 8th	It costed 2000 mark to buy them those times.	5s
Neutral 9th - Baseline	Miele company prepared the first electrical washing machine with drying function in 1958.	5s
10th Task	When the counter reaches zero again, start singing a song aloud by your own choice without changing your body position.	5s

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