PHYSIOLOGICAL BASIS OF TRYPOPHOBIA

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ETHICAL DECLARATION

I hereby declare that I am the sole author of this thesis and that I have conducted my work in accordance with academic rules and ethical behaviour at every stage from the planning of the thesis to its defence. I confirm that I have cited all ideas, information and findings that are not specific to my study, as required by the code of ethical behaviour, and that all statements not cited are my own.

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ABSTRACT

PHYSIOLOGICAL BASIS OF TRYPOPHOBIA

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The behavioral immune system (BIS) is a type of motivational system that is assumed to have evolved throughout natural selection process against the threat of infectious disease. It is believed that BIS has two basic structural components, perceptual and response. The response component of the BIS is specifically linked to processes associated with disgust. It was pointed out that there are two types of disgust known as contamination disgust and mutilation disgust that differ from each other on the physiological level. On the other hand, studies have shown that individuals with trypophobia experience disgust at extreme levels to clusters of small objects which are known as trypophobic stimuli. Following this, this thesis had two

aims. The first was to examine the effect of trypophobia sensitivity and trypophobic stimulus category on physiological processes. The second was to investigate whether differentiation between trypophobic and healthy participants at the physiological level during trypophobic stimulation varies depending on the type of trypophobic stimulus used. Results suggested that trypophobic individuals did not differ from healthy individuals during trypophobic stimulation on the basis of recorded physiological processes. In addition, findings showed that groups did not differ depending on category of trypophobic stimulus used to achieve trypophobic stimulation. On the other hand, the results of the analysis revealed that, in general, EDA increased more substantially for participants who were exposed to skin-relevant stimuli compared to those who were exposed to non-skin-relevant stimuli. We discussed the implications of these findings in the discussion section.

Keywords: Behavioral immune system, disgust, heart rate, heart rate variability, electrodermal activity, trypophobia

ÖZET

TRİPOFOBİNİN FİZYOLOJİK TEMELLERİ

Öztürk, Süleyman

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Davranışsal bağışıklık sistemi bulaşıcılık hastalık tehdidine karşı doğal seçilim sürecinde evrildiği varsayılan bir tür motivasyonel sistemdir. Davranışsal bağışıklık sisteminin algısal ve tepkisel olmak üzere yapısal olarak iki temel bileşeninin olduğu düşünülmektedir. Çalışmalar davranışsal bağışıklık sisteminin tepkisel bileşeninin özellikle tiksinme ile ilişkili süreçlerle bağlantılı olduğunu göstermiştir. Son dönemde yürütülen bir derleme çalışmasında tiksinmenin bulaşmaya bağlı ve yaralanmaya bağlı tiksinme olarak fizyolojik düzlemde birbirinden farklılaşan iki türünün olduğuna işaret edilmiştir. Öte yandan, yürütülen çalışmalar tripofobisi olan bireylerin tripofobik uyaran olarak adlandırılan küçük objelerin oluşturduğu

kümelere karşı aşırı düzeyde tiksinme deneyimledikleri göstermektedir. Literatürde, tripofobik uyaranlar deri ile ilişkili olanlar ve deri ile ilişkili olmayanlar olarak iki alt kategoride incelenmektedir. Buradan hareketle, bu tez çalışmasının iki amacı bulunmaktadır. İlki, tripofobik hassasiyetin ve tripofobik uyaran türünün fizyolojik süreçler üzerindeki etkisini incelemektir. İkincisi, tripofobik ve sağlıklı katılımcılar arasındaki farklılaşma seviyesinin kullanılan tripofobik uyaran türüne bağlı olarak ne ölçüde değiştiğini araştırmaktır. Yürütülen analizler sonucunda, tripofobik bireylerin sağlıklı bireylerden ölçülen fizyolojik süreçler bağlamında birbirinden farklılaşmadığı bulunmuştur. Buna ek olarak, bulgular bu sonucun tripofobik uyaran türüne bağlı olarak da değişmediğini göstermektedir. Öte yandan, analiz sonuçları, genel olarak, deri uyaranına maruz kalan katılımcılarda elektrodermal aktivitenin deri ile ilişki olmayan uyarana maruz kalan katılımcılara kıyasla daha yüksek düzeyde arttığını göstermektedir. Elde edilen bu bulguların implikasyonları tartışma bölümünde detaylı bir şekilde tartışılmıştır.

Anahtar Kelimeler: Davranışsal bağışıklık sistemi, tiksinme, kalp atış hızı, kalp atış hızı değişkenliği, elektrodermal aktivite, tripofobi

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CHAPTER 1: INTRODUCTION

The evolutionary perspective assumes that the main goal underlying all behavior of organisms including homo sapiens is to enhance reproductive fitness (Kenrick et al., 2010). Reproductive fitness refers to the organisms' capacity to pass their genes to subsequent generations (Kosova, Abney, and Ober, 2010). However, in the course of the evolutionary process, achieving this goal requires more than just the ability to reproduce. Indeed, organisms needed to deal with various challenges, and for humans, these challenges include finding resources essential to survival (e.g., food), protecting themselves from external threats (e.g., predators), finding suitable mates, and building socially strong bonds with others (Kenrick et al., 2010). Since the nature of these evolutionary problems differed greatly from one another, behaviors being adaptive in dealing with each problem differed a great deal as well (Kenrick and Shiota, 2008). For example, behaviors that are beneficial in food acquisitions involve exploration, chasing, capturing, and ingesting of available resources whereas protection from threats concerning predators involves anxiety or fear-related behaviors such as flight, freezing, and counterattack (Timberlake, 2012; Rau, and Fanselow, 2007). This differentiation in the structure of functional behaviors can even be observed between adaptive behaviors related to reproduction and essential resource acquisition although both evolutionary challenges require approach-related behaviors (for the reproductive system, see Domjan, and Gutierrez, 2019). Because different adaptive problems require the engagement of functionally different behaviors, it was hypothesized that organisms adapted to equip different systems that each address a different evolutionarily challenge (Kenrick et al., 2010). Following this view, the evolutionary perspective in psychology considers the human mind a type of biological machine comprising different motivational systems that evolved to promote goal-directed behaviors that have been proven to be adaptive in attaining specific evolutionary goals throughout natural selection (Neuberg, Kenrick, and Schaller, 2011).

Although evolved motivational systems are domain specific in the sense that each of which are functional in dealing with a specific evolutional challenge, it was suggested that they operate based on similar principles (Neuberg, Kenrick, and Schaller, 2011). For instance, efficient problem-solving requires identifying the problem first, and thus motivational systems were designed by natural selection in a way that they show sensitivity to particular environmental cues that signal the existence of the problem (Kenrick et al., 2010). In support of this, for example, it has been shown that animals that have threatened human life through evolutionary processes such as snakes are detected by the human visual system faster than other animals that are not related to the threat (Öhman, Flykt, and Esteves, 2001; Isbell, 2006). This finding was also supported by different neuroscientific studies as well (Van Le et al., 2013; Van Strien, Franken, and Huijdinget, 2014). Similar to snakes, angry facial expressions, another evolutional threat-relevant stimulus, were also found to be detected faster by the visual system compared to neutral faces (Pinkham et al., 2010; Shasteen, Sasson, and Pinkham, 2014) especially when they are expressed by men (Becker et al., 2007). Furthermore, following to detection of the problem, efficient problem-solving also requires mobilizing functional processes for the solution of the present problem. Thus, another common feature of motivational systems is to trigger adaptive processes following the detection of environmental cues of a relevant evolutional problem (Neuberg, Kenrick, and Schaller, 2011). In line with this, studies showed that organisms, in response to a threat cue, exhibit a variety of adaptive defensive reactions such as escape, freezing, and counterattack (Fanselow, and Lester, 1988; Rau, and Fanselow, 2007).

It has been suggested that defensive responses to threats are to some extent species-specific, as each species has a different phylogenetic history. (Bolles, 1971). In humans, these adaptive defensive responses are considered to be related to anxiety, fear, and panic states (Craske, 1999). Finally, it was suggested that these evolved systems are functionally flexible such that their engagement level differs from situation to situation (Neuberg, Kenrick, and Schaller, 2010; Neuberg, Kenrick,

and Schaller, 2011). For example, when the temporal distance between conditioned stimulus (CS) and shock is long in eyeblink conditioning where a mild shock is delivered near the eye, rabbits showed an increase in heart rate as a conditioned response (CR) (Bouton, 2005). However, in the same conditioning paradigm, rabbits developed a blink response together with the heart rate increase as CR when the temporal distance between CS and shock is relatively shorter. This finding indicates that the structure of displayed defensive responses differs based on the temporal distance of the threat. Furthermore, several conditioning studies conducted with animals revealed that the frequency and magnitude of defensive responses increase as the intensity and probability of threat increase (Polenchar et al., 1984; Rescorla, 1968). Thus, in addition to temporal distance, the type of defensive behavior displayed against environmental threats is affected by the probability of the threat, and how dangerous the threat-relevant stimulus is perceived (Fanselow, Hoffman, and Zhuravka, 2019). Finally, it has also been proposed that the exhibition of defensive behaviors is influenced by individual differences (Neuberg, Kenrick, and Schaller, 2011). For example, studies showed that the magnitude of defensive reactions such as startle reflex and freezing were observed more strongly in individuals with high trait anxiety in comparison to those with low trait anxiety during threat anticipation (Sege, Bradley, and Lang, 2018; Poli and Angrilli, 2015; Hashemi et al., 2021). Moreover, studies also revealed that threat-relevant stimuli are detected faster and hold attention longer in highly anxious individuals in comparison to healthy controls suggesting that defensive system engagement is relatively higher in those with high anxiety (Cisler, and Koster, 2010; Fox et al., 2001). Thus, the organization of adaptive processes related to the evolved defensive system is not strict but flexible such that the topography of displayed behavior changes based on both properties of the present threat and the characteristics of individuals.

It should be noted that this flexible organization is not specific to the defensive system but is a common feature of all motivational systems. For example, in one study where a predictive CS is paired with a food piece, rats developed

searching at a distance from the food tray as CR if the temporal distance between CS and US is long. However, the animal developed sniffing around the food tray as CR if the temporal distance between CS and US is shorter (Timberlake, 2001).

1.1. Behavioral Immune System

Protection against infectious diseases has been also one of the evolutionary challenges ancient humans needed to sort out. In particular, infectious diseases have imposed strong selection pressures on human evolution as being one of the main causes of human death in the process of natural selection (Schaller, 2016). For example, it is estimated that one-third to two-thirds of Europe's population died from the black death in the 14th century (Shaw-Taylor, 2020). Accordingly, humans were proposed to have evolved a range of adaptations to deal with pathogens – biological agents (e.g., viruses, bacteria) that cause infectious diseases following contagion – (Ackerman, Hill, and Murray, 2018).

The physiological immune system (PIS) is one of the adaptive systems that have evolved against the threat of pathogens. PIS is considered a biological network of large cell and protein communities whose function is to protect different parts of the body, such as the skin and respiratory tract, against pathogens (Marshall et al., 2018). Whereas this system is highly functional in mitigating the presence of pathogens in the organism, its activation has several disadvantages as well (Schaller, 2016; Murray, and Schaller, 2016). For instance, Schaller (2016) argues that activation of the PIS can be quite costly for organisms as it requires high energy consumption. Studies showed that an increase in body temperature was a functional process deployed by the PIS against infections due to slowing down the reproduction rate of pathogens entering the body and enhancing the activity of immune system cells (Maier, and Watkins, 1998). However, increasing body temperature may be a quite demanding process for an organism such that for a 1 °C increase in body temperature following pathogen entry into the body, the current metabolic rate of the

organism should increase by 13% (Baracos, Whitmore, and Gale, 1987). Another disadvantage of the PIS pointed out by Schaller is that it is effective against infections only after pathogens enter the body. Thus, the reactive nature of the immune system provides relatively "free time" for pathogens to damage body structures. Finally, the PIS deploys a variety of adaptive changes called acute phase responses to facilitate recuperation processes (Daruna, 2012; Maier, and Watkins, 1998). In addition to the increase in body temperature, these changes include an increase in pain sensitivity and need for sleep, and a decrease in appetite, social interaction, sexual and aggressive behaviors. While these changes are highly functional in the recovery, Schaller (2016) argues that they also preclude organisms from successfully coping with other evolutionary challenges, such as predatory threats or finding suitable mates.

Given that there are certain shortages related to the activation of PIS, some researchers suggested that humans have evolved to equip a distinct adaptive system that promotes goal-directed behaviors that are functional in the defense against infections (Schaller and Duncan, 2007; Schaller, and Park, 2011). This system is a type of motivational system similar to the ones described above, and it is called the behavioral immune system. The behavioral immune system (BIS) differs from the physiological immune system mainly in its activation context (Neuberg, Kenrick, and Schaller, 2011; Schaller, 2016). PIS, as noted above, is a reactive mechanism in the sense that related processes are mainly deployed following to entry of infection agents into the body, and therefore their main purpose is to mitigate pathogens present in the body. On the other hand, BIS is a pro-active mechanism implying that related processes are deployed in response to perceptual cues connoting potential infection risk, and so their main function is to avoid (instead of fighting) infection by preventing pathogens' entry into the body. Thus, BIS is a system adaptive in pathogen avoidance, and it helps organisms to deal with infection threats without the need for costly activation of PIS.

1.1.1. Components of BIS

1.1.1.1. Perceptual Component

It was proposed that similar to other motivational systems, BIS has two components: perceptual and response (Neuberg, Kenrick, and Schaller, 2011). The perceptual component is functional in the detection of cues connoting infection threats in the environment. In support of this, studies showed that pathogen-relevant stimuli are prioritized and detected faster in stimulus selection by the human visual system (Carretié et al., 2011; van Hooff et al., 2013). It was also shown that pathogen-relevant stimuli hold attention longer in comparison to neutral stimuli (Charash, and McKay, 2002; Cisler et al., 2009; Chapman et al., 2013). In a study conducted by Cisler et al. (2009), the duration of attentional disengagement from pathogen-relevant stimuli was found to be associated with participants' disgust propensity such that attention disengagement took longer as disgust proneness scores increased. It was suggested that the human visual system was likely to show sensitivity to visible symptoms of various diseases (e.g., skin lesions, coughing) to avoid infection (Neuberg, Kenrick, and Schaller, 2011; Oaten, Stevenson, and Case, 2009). Furthermore, other studies have suggested that the BIS is sensitive to cues from different sensory modalities in addition to visual cues. One such cue is likely to be body odor given that different studies found that people's odor changes depending on the status of PIS regarding whether or not the organism is fighting against an infection. In support of this, studies revealed that the human olfactory system is sensitive to the odors of others, and it can distinguish the odors of sick individuals from healthy ones (Kramer, and Essan, 2021). In one study, participants were asked to rate the intensity, pleasantness, and health status of various body odors including sick individuals (Olsson et al., 2014). Results showed that the odors taken from sick individuals were evaluated as more irritating, intense, and unhealthy compared to the odors of healthy individuals and neutral odors.

Although the behavioral immune system is quite functional in the detection of pathogens, some studies showed that it also tends to interpret stimuli unrelated to pathogens as threatening. For example, it has been shown that, similar to real infection sources, disfigured faces that are not an indicator of any known infectious diseases were shown to hold the attention longer and activate BIS (Ackerman et al., 2009; Ryan et al., 2012). Likewise, Miller and Manner (2012) showed that obese appearances are also perceived as an infection threat by BIS. Furthermore, in the same study, the tendency of BIS to perceive benign cues as an infection threat was especially observed when individuals consider themselves vulnerable to disease contagion. The fact that the BIS is prone to perceive some of the pathogen-irrelevant stimuli as infection threats were suggested to be an evolutionary bias (Schaller, 2015). In particular, it was argued that the detection of pathogen threats on the basis of superficial cues makes detection processes prone to errors (Murray, and Schaller, 2016; Ackerman, Hill, and Murray, 2018). There are two types of errors in the detection of pathogen-related cues that can be made by the BIS: perceiving real threats as benign (false-negative) and perceiving innocuous cues as real threats (false-positive) (Murray, and Schaller, 2016). Since it is impossible in practice to reduce simultaneously the likelihood of making these two types of errors (Green, and Swets, 1966), Error Management Theory (EMT) proposes that, in such circumstances, adaptive systems evolved in a way that they are biased to make errors with lower evolutionary costs compared to those with higher evolutionary costs (Haselton, and Buss, 2000; Haselton, and Nettle, 2006). In the context of infectious disease threats, perceiving real threats as naïve is more costly due to enabling possible contagion relative to perceiving innocuous cues as threatening (Murray, and Schaller, 2016; Schaller, 2015). Therefore, the EMT perspective suggests that BIS evolved to perceive certain physical and cognitive abnormalities as threatening although they are not related to infection threat.

1.1.1.2. Response Component

The response component of BIS is functional in reducing or removal of the potential infection threat (Neuberg, Kenrick, and Schaller, 2011). In response to cues associated with infection threat, BIS was suggested to promote actions characterized by disgust emotion such as facial expressions that prevent entry into the nose (e.g., nose wrinkling) and mouth (e.g., down-turning of mouth corners), nausea and revulsion feeling, vomit, itchiness, rubbing the skin, skin-crawling and hair-raising sensations, withdrawal, distancing, and avoidance (Blake et al., 2016; Curtis, de Barra, and Aunger, 2011; Davey, 2011; Rubio-Godoy, Aunger, and Curtis, 2007). Various studies showed that disgust is elicited by the perception of stimuli related to pathogens such as disease symptoms (e.g., runny noses), body products (e.g., feces), animal vectors (e.g., cockroaches), foods (e.g., rotten meat), and wounds (Curtis, and Biran, 2001; Curtis, Aunger, and Rabie, 2004; Oaten, Stevenson, and Case, 2009). For example, Bradley et al. (2001) presented participants with pictures each of which was related to different emotions, and they found that disgust was more likely to be evoked in response to pictures associated with infection threat. Furthermore, in one qualitative study (Curtis, and Biran, 2001), participants from different countries were asked to indicate stimuli that make them feel disgusted. Then, the sources of modern infectious diseases were compared with the list of disgust elicitors commonly identified by participants. The researchers noted that they observed a large degree of overlap between sources of infections and elicitors of disgust. The fact that the experience of disgust against pathogen-related stimuli was found to be observed across a variety of cultures confirms the idea that disgust is a type of evolved avoidance mechanism against infection threats.

Similar to other adaptive motivational systems, it was argued that BIS is a functionally flexible system such that the engagement of BIS-related processes changes depending on the properties of the present threat and the individual differences (Ackerman, Hill, and Murray, 2018; Schaller, and Park, 2011). This suggests that perception of low threat results in low-level activation of BIS-related

processes whereas perception of high threat results in higher-level activation (e.g., more intense disgust experience). One factor likely to determine the reactivity of BIS is the threat level of pathogen-related stimuli present in the context (Murray, and Schaller, 2016). For example, Stevenson and Repacholi (2005) showed that participants evaluated aversive body odors that are associated with pathogens as more disgusting when these odors belonged to a stranger. It was argued that BIS is likely to perceive pathogen-relevant cues as more threatening when they are expressed by a stranger as individuals from out-group (relative to in-group individuals) have been more likely to carry pathogens to which the individual is vulnerable throughout evolutionary history. This effect is known as the "source effect" (Oaten, Stevenson, and Case, 2009). In a similar vein, studies revealed that mothers rated the diapers of other people's babies as more repulsive than their own (Case, Repacholi, and Stevenson, 2006), and participants who were primed for infectious disease concerns evaluated consumer products previously used by others as less valuable than new ones (Huang, Ackerman, and Sedlovskaya, 2017).

The level of BIS engagement is also influenced by personality traits including pathogen disgust sensitivity (PDS) and perceived vulnerability to disease (PVD) (Schaller, and Park, 2011; Neuberg, Kenrick, and Schaller, 2011). For example, one study (Shook et al., 2020) revealed that pathogen disgust sensitivity (PDS) (i.e., the level of how easily disgust is experienced in response to pathogen-relevant stimuli) is a unique predictor of infectious disease concerns (i.e., Covid-19), and the frequency of performing preventive health behaviors such as social distancing and cleaning. Furthermore, in the same study, preventive health behaviors were also found to be associated with participants' general perception of health. Another study (Olatunji et al., 2008) showed individuals' level of disgust sensitivity is a unique predictor of visually avoiding relevant disgust elicitors. Additionally, Makhanova and Stepherd (2020) showed that those who were higher in PVD were more likely to experience elevated Covid-19 anxiety and believe in the effectiveness of social distancing in the prevention of Covid-19 transmission. PVD was also found to be associated with

health-promoting behaviors related to both communicable (e.g., avoiding casual sex) and non-communicable diseases (e.g., seeing a doctor following the experience of repeated headaches) (Gruijters et al., 2016).

1.1.2. Domain-specificity of BIS at Different Levels

As noted above, the fact that successful management of different adaptive challenges required specific perceptual and behavioral organizations led to the evolution of functionally domain-specific motivational systems. Unsurprisingly, the operation of these systems is the product of certain neurobiological and physiological processes in organisms (Neuberg, Kenrick, and Schaller, 2010; Neuberg, Kenrick, and Schaller, 2011). Following this idea, it can be expected that the domain specificity in functional organizations can be observed at neural and physiological levels as well as behavioral (Neuberg, Kenrick, and Schaller, 2011). For example, at the behavioral level, it was noted previously that BIS was suggested to be associated with disgust-related responses (Davey, 2011). Similarly, at the neural level, studies revealed that the perception of disgust elicitors (Phillips et al., 1998; Sprengelmeyer et al., 1998) and the experience of disgust (Fitzgerald et al., 2004; Stark et al., 2007) are specifically associated with the functioning of the insular cortex and basal ganglion regions. In one study (Phillips et al., 1997), participants were asked to indicate the sex of facial expressions specifically related to either fear or disgust. Results showed that disgust expressions activated primarily anterior insula, and putamen which is a part of basal ganglia. Furthermore, Calder et al. (2000) reported an individual experiencing difficulty in identifying disgust stimuli and a reduction in the intensity of expressed disgust. It was noted by the authors that the individual taking part in this case study was diagnosed previously with Huntington's disease resulting from lesions in parts of basal ganglia and insula.

1.1.2.1. Domain-specificity of BIS at the Physiological Level

Numerous studies revealed that the functioning of BIS is associated with specific physiological processes (Kreibig, 2010). Although there are a variety of physiological indices (e.g., blood pressure, total peripheral distance, stroke volume) shown to be related to BIS functioning (Rohrmann, and Hopp, 2008), three indices were more extensively investigated: electrodermal activity (EDA), Heart Rate (HR), Heart Rate Variability (HRV).

1.1.2.1.1. Heart rate (HR), Heart rate variability (HRV), and BIS functioning.

Several psychophysiology studies revealed that disgusting stimuli were associated with specific changes in heart rate (HR) and heart rate variability (HRV). Heart rate simply refers to the measurement of the number of beats per minute (Shaffer, and Ginsberg, 2017). On the other hand, heart rate variability (HRV) refers to the quantification of variability between successive heartbeats (Forte, Favieri, and Casagrande, 2019). This variability between consecutive heartbeats was observed to persist even in cases in which the homeostatic balance was not disturbed (Shaffer, McCraty, and Zerr, 2014). Following this view, it is suggested that the observed variability in the functioning of biological systems including the heart is adaptive in that it facilitates systems to quickly adapt to ever-changing conditions (Beckers, Verheyden, and Aubert, 2006; Fiskum et al., 2018).

It is generally assumed that increased parasympathetic activity is a physiological marker of disgust experience (Woody, and Teachman, 2000). For instance, in one study (Lang et al., 1993), participants were presented with pictures of different emotional contents such as disgust, fear, and neutral. Findings indicated that disgusting pictures, differing from fearful and neutral pictures, led to a decrease in heart rate which was assumed to be one of the outputs of increased parasympathetic activity on the cardiovascular system. Similar results were also obtained by studies in which disgust induction was accomplished via mimicking,

although changes in heart rate were small (Levenson, Ekman, and Friesen, 1990). Another study revealed that the intensity of disgust experienced by participants correlated negatively with HR observed in participants during the presentation of disgust pictures (Stark et al., 2005). Although studies mostly indicated that disgust experience is accompanied by a decrease in HR (Gross, 1998; Johnsen, Thayer, and Hugdahl, 1995), some studies found no change (Lang et al., 1993) or increase (Schienle, Stark, and Vaitl, 2001; Vernet-Maury et al., 1999) in HR during disgust experience. On the other hand, it has been suggested that such contradicting findings may be the result of the use of imagination procedures requiring cognitive effort (de Jong, van Overveld, and Peters, 2011). In the context of HRV, in line with the idea of predominant parasympathetic activity in disgust-relevant processes, higher vagally mediated HRV was found in participants who were presented with disgusting film clips or auditory scripts compared to those who were presented with neutral (de Jong, van Overveld, and Peters, 2011; Comtesse, and Stemmler, 2016; Comtesse, and Stemmler, 2017) and fearful contents (Ruiz-Padial et al., 2018). Ottaviani et al. (2013) also found higher vagally mediated HRV during disgust induction accomplished via auditory scripts in comparison to the participants' baseline values, although no significant change in HR was reported. On the other hand, there are some views suggesting that there are different types of disgust experience, and therefore observed changes in HR and HRV in response to disgust elicitors might differ as a function of the experienced disgust type. Consistent with this idea, Kreibig (2010) argued in her review that an increase or no change in heart rate and an increase in HRV accompanied the type of disgust – referred to as contamination disgust – expressed against pictures of dirty toilets, cockroaches, and maggots in the food. On the other hand, a decrease in heart rate and no change in HRV was observed during the disgust experience – referred to as mutilation disgust – expressed against injections, scenes of mutilation, and injuries.

1.1.2.1.2. Electrodermal activity (EDA) and BIS functioning.

Electrodermal activity (EDA) refers to electrical activity in the human skin, and it changes as a function of sweating (Gersak, 2020). Since parasympathetic activity has no known effect on sweating, EDA is one of the most sensitive indices of changes in sympathetic activity and directly reflects these changes (Critchley, 2002).

It has been consistently shown that disgust experience is associated with heightened EDA and therefore heightened arousal (Kreibig, 2010). For example, Schienle, Stark, and Vaitl (2001) presented participants with scenes varying in emotional content (disgusting, pleasant, and neutral), and reported that disgusting scenes caused a stronger increase in SCR relative to other scenes. Furthermore, in a study (Stark et al., 2005), EDA was measured in participants while they were viewing images differing in disgust intensity. Affective ratings of participants concerning images were also obtained after physiological recording. Results revealed a positive relationship between disgust ratings of images and SCR displayed by participants. An increase in SCR related to disgust experience was found even when participants were instructed to display facial expressions of disgust by themselves (Levenson et al., 1990). Heightened EDA concerning disgust experience was also found in studies investigating tonic electrical activity. For instance, in one study (Vianna, and Tranel, 2006), participants were presented with emotional film clips designed to induce different emotions (happiness, disgust, fear, sadness, or neutral). Results indicated that viewing disgusting films led to a higher increase in SCL compared to other emotion-relevant films (except fear). Studies also revealed no difference between disgust domains regarding EDA. For example, Rohrmann and Hopp (2008) conducted a study in which participants were presented with three film clips involving different emotional contents. One film clip was depicting a person who was vomiting whereas the other film clip was depicting amputation of the upper extremity. Here, researchers categorized disgust domains as either food-relevant or disease-relevant, and vomiting video was considered related to food-relevant disgust, and amputation was considered disease-relevant disgust. The last film clip was

intended to be emotionally neutral. Results indicated no difference in SCL of participants between disgust domains whereas film clips of both domains of disgust evoked higher SCL than the neutral clip.

Taken together, although early studies considered disgust experience mainly related to parasympathetic activity, it seems that the experience of disgust can be characterized by the coactivation of the parasympathetic (e.g., increased vagally mediated HRV) and sympathetic branches of the autonomic nervous system (e.g., increased EDA) (Kreibig, 2010). From a theoretical point of view, observed parasympathetic system processes during disgust experiences may be related to the need for detailed processing of pathogen-relevant stimuli (Ruiz-Padial, and Ibanez-Molina, 2018). Indeed, it is often the case that infection threats in the environment are not as noticeable as fear-relevant threats, and therefore detection of such stimuli requires more elaborative information processing compared to fear-relevant threats (Carretié et al., 2011). Recent studies showed that parasympathetic system processes, especially vagally mediated HRV, are related to top-down cognitive functions related to prefrontal cortex activation (Thayer et al., 2009; Park, and Thayer, 2014). On the other hand, observed sympathetic system processes during the disgust experience may function to facilitate disgust-relevant avoidance and withdrawal, if needed (Ottaviani et al., 2013).

1.2. Trypophobia

Trypophobia refers to a condition in which individuals experience excessive avoidance and fear toward stimuli (e.g., honeycomb, strawberry's surface) containing clusters of small holes and bumps (Cole, and Wilkins, 2013). It is estimated to affect around 15% of the population (Cole, and Wilkins, 2013); however, it is not considered psychopathology since it is not yet defined in DSM-V (American Psychiatric Association, 2013). On the other hand, the trypophobia condition is very similar to specific phobias previously defined in DSM-V and an early study revealed

that major depressive and generalized anxiety disorder were the most commonly observed comorbidities (Vlok-Barnard, and Stein, 2017).

1.2.1. Features of Trypophobic Stimuli

Studies revealed that the level of trypophobic discomfort experienced by individuals is associated with features of trypophobic stimuli. For instance, Le, Cole, and Wilkins (2015) presented trypophobic individuals with object clusters containing different numbers of small objects. Results showed that participants experienced higher discomfort as the number of objects on trypophobic stimuli increased. Furthermore, in the same study (Le, Cole, and Wilkins, 2015), participants were also presented with different types of object clusters. Object clusters including both holes and bumps on the surface were more uncomfortable to observe for trypophobic individuals compared to objects including only holes or bumps. Another study revealed that trypophobic individuals found small clusters of objects on the skin more disturbing than those found on other surfaces (Kupfer, and Le, 2018). Interestingly, studies have also shown that trypophobic stimuli are also discomforting for the general population, albeit to a lesser degree (Furuno et al., 2018; Furuno et al., 2017). Accordingly, this finding suggests that humans may be sensitive to small clusters of objects in general, but this sensitivity can be a matter of degree, such that it is exaggerated in trypophobic individuals.

1.2.2. Symptoms of Trypophobia

Le, Cole, and Wilkins (2015) explored symptoms of trypophobia under three distinct categories: skin-related symptoms, emotional symptoms, and physiological symptoms. Skin-related symptoms included itchiness and skin crawling; emotional symptoms included disgust, fear, anxiety, and uneasiness; physiological symptoms included nausea, heart palpitations, vomiting, and trouble with breathing. Unlike many phobias that have been defined so far, a number of studies have revealed that the vast majority of trypophobic individuals experience primarily disgust in response

to phobic stimuli rather than fear. For example, trypophobic individuals reported in two studies that they experienced more predominant disgust for small clusters of objects than fear (Kupfer, and Le, 2017; Vlok-Barnard, and Stein, 2017). In another study, Le, Cole, and Wilkins (2020) presented participants with 10 trypophobic non-skin stimuli and 10 neutral stimuli. They found a higher increase in HR and HRV in trypophobic individuals in comparison to neutral pictures. Given that increased HR and HRV is an indicator of contamination-related disgust (Kreibig, 2010), Le, Cole, and Wilkins (2020) concluded that trypophobic individuals experience primarily contamination-related disgust toward clusters of small objects. Moreover, two studies confirmed the idea that trypophobic stimuli led to disgust-related ANS changes in participants, such as the constriction of the pupil (Ayzenberg, Hickey, and Lourenco, 2018) and increased skin conductivity (Pipitone, Gallegos, and Walters, 2017). However, Pipitone, Gallegos, and Walters, (2017) found no effect of trypophobic stimulation on HR. Accordingly, trypophobia may be a type of psychopathology associated with dysfunctions of BIS-related mechanisms. On the other hand, trypophobia is not the only psychopathology that may be possibly associated with dysfunctions of BIS. Indeed, recent studies revealed that individuals who have been diagnosed with spider phobia or blood-injection-injury type phobia experience considerable disgust toward phobia objects as well as fear (Cisler et al., 2009; Davey, 2011; Olatunji et al., 2010). For example, de Jong et al. (2002) found that individuals with a fear of spiders exhibited more disgust-related facial expressions when exposed to spiders than the healthy group. Furthermore, Goossens et al. (2007) and Wendt et al. (2008) observed that insular cortex and amygdala activation was higher during the presentation of spiders in individuals with spider phobia compared to the control group. Interestingly, Mayor et al. (2021) found that there was a high level of similarity between the symptoms of trypophobia and the symptoms observed in spider and blood-needle-injury phobias in terms of their relationship with personality variables such as disgust sensitivity, behavioral inhibition, and anxiety sensitivity. For example, results indicated that as individuals' disgust sensitivity level increased,

the severity of symptoms in trypophobia, spider phobia, and blood injection phobia increased.

1.2.3. Etiology of Trypophobia

Regarding the etiology of trypophobia, two explanations have been proposed so far. Firstly, Cole and Wilkins (2013) argued that people found trypophobic stimuli discomforting as there was a similarity between trypophobic stimuli and patterns found on the surface of some poisonous animal species such as octopus, scorpion, and jellyfish found in nature. However, findings that trypophobic stimuli primarily lead to disgust experience rather than fear that is commonly triggered by poisonous animals above reduce the likelihood of which this explanation is acceptable. Following this, Kupfer and Le (2017) suggested that trypophobic stimuli are discomforting for people since object (e.g., holes) clusters have been evolutionarily a sign of pathogen presence for stimuli they are on. For example, researchers pointed out that individuals who have been diagnosed with monkeypox, smallpox, or typhus disease have clusters of bumps on their skin. In addition to people diagnosed with infectious diseases, clusters of small objects are also found on the surface of many spoilt organic substances (e.g., moldy bread) (Amendt, Krettek, and Zehner, 2004). Considering this, Kupfer and Le (2017) concluded that clusters of small objects may have functioned as an indicator of pathogens throughout the evolutionary process, and therefore humans may have evolved to experience discomfort against clusters of small objects so that they can avoid contact with infectious diseases. The fact that various studies found that trypophobic stimuli trigger disgust-related processes in humans, which is an adaptive response to prevent transmission of BIS, supported the idea that humans perceived an infection threat from trypophobic stimuli. Furthermore, two studies showed that trypophobic stimuli were processed in the visual system similar to other evolutionarily significant stimuli (e.g., snake) (Shirai, and Ogawa, 2019; Van Strien, and Van der Peijl, 2018). For example, researchers in an EEG study observed that the trypophobic stimulus, similar to snake, induced stronger early posterior negativity (EPN) than bird did (Van Strien, and Van der

Peijl, 2018). Given that EPN activity was considered as an index of the significance of stimuli in the evolutionary context (Schupp et al., 2003), observed high-level EPN activity during exposure to trypophobic stimuli was taken as evidence of the idea that trypophobic stimuli are one of the evolutionarily significant stimuli for humans.

However, if object clusters are evolutionarily aversive stimuli for humans, one can ask why some individuals (known as trypophobic) feel discomfort at more extreme levels toward these stimuli in comparison to the general population. Kupfer and Le (2017) suggested that this difference between trypophobic and healthy individuals may be related to the learning history of those with trypophobia. In particular, according to this view, pathological trypophobic discomfort may develop following a classical conditioning process that involves associating small clusters of objects with a negative outcome related to contamination. For example, this view proposes that trypophobia may develop after an experience in which the person suffers from a skin-related disease whose symptoms on the skin are similar to clusters of objects. Here, the association is established between the appearance of clusters of small objects and the infectious disease state. Supporting the possible contribution of negative learning experiences to the etiology of trypophobia, a study found that those who have previous skin-related disease experiences reported more discomfort with trypophobic stimuli (Yamada, and Sasaki, 2017). On the other hand, in another study, participants with trypophobia reported that they did not remember a history of negative experiences with clusters of small objects (Vlok-Barnard, and Stein, 2017). However, this finding does not invalidate the explanation of Kupfer and Le (2017) since it is suggested that phobic level responses can develop easily toward evolutionarily significant stimuli without requiring extensive experience. For example, it was shown that rhesus monkeys can associate the snake with shock after a few trials whereas more training was needed to establish the same level of association between flower/mushrooms and shock (Öhman, and Mineka, 2001; Mineka, and Öhman, 2002). From this perspective, Kupfer and Le (2017) suggested that phobic level aversion toward object clusters may develop after a mild

experience. Furthermore, it has been long known in psychology that direct experiences are not a must for learning to occur. Rather, learning can also take place through other ways such as observation or verbal instruction. Thus, the reason why individuals with trypophobia do not remember their negative experiences with object clusters is the possibility that pathological trypophobic discomfort may develop following a mild experience and/or indirect experience such as observation.

Taken together, studies carried out so far suggest that small object clusters may be an aversive stimulus for the general population owing to their evolutionary association with pathogen presence. Therefore, humans may have evolved in a way that they avoid such stimuli to protect themselves from infection. On the other hand, trypophobia may refer to a state in which this adaptive aversion toward object clusters is exaggerated possibly as a result of the combined contribution of learning experiences and different risk factors (e.g., disgust sensitivity).

1.3. Present Study

We structured this thesis study around three aims. Firstly, we tried to examine whether trypophobic and healthy participants differ from each other at the physiological level during trypophobic stimulation. Secondly, we tried to examine whether physiological processes in both healthy and trypophobic individuals show differentiation depending on the type of trypophobic stimuli used to achieve trypophobic stimulation. Thirdly, we tried to investigate whether the extent of differentiation between trypophobic and healthy participants during trypophobic stimulation varies depending on the type of trypophobic stimulus used to achieve trypophobic stimulation. In order to reach these goals, participants initially were asked to fill out a trypophobia questionnaire. According to their scores on the trypophobia questionnaire, they were divided into two groups trypophobic and healthy. Furthermore, participants were again randomly divided into two groups: the skin group and the non-skin group. While skin-relevant trypophobic stimuli were

used for the skin group to carry out trypophobic stimulation, non-skin trypophobic stimuli were used for the other group to carry out trypophobic stimulation. Participants' HR, HRV, and EDA were recorded for 15 minutes before the stimulus presentation and during the stimulus presentation. To ensure that participants attended to images, we implemented a task that required them to indicate whether the current picture was the same or different from the picture they had viewed two rows back.

As noted previously, prior studies proposed that individuals with high trypophobia sensitivity experienced higher levels of disgust towards trypophobic stimuli compared to those with low trypophobia sensitivity (Kupfer ve Le, 2017; Imaizumi et al., 2016). Given that there is a close relationship between contamination disgust experience and heightened EDA, HR, and vagal HRV (Kreibig, 2010), we predicted that the amount of increase in HR, vagally-mediated HRV, and EDA from the pre-experiment to the experimental stage will be greater for trypophobic individuals compared to healthy individuals. Furthermore, past research also revealed that both healthy and trypophobic individuals reported more disgust and discomfort to skin-relevant stimuli in comparison to non-skin-relevant stimuli (Furuno et al., 2018; Furuno et al., 2017; Kupfer, and Le, 2017). Following this, we predicted that when skin-relevant stimuli are presented, the level of increase in HR, vagal-mediated HRV, and EDA for both trypophobic and healthy individuals will be higher than when non-skin-relevant stimuli are presented.

We would like to note that our study is unique in several aspects. Le, Cole, and Wilkins (2020) previously explored the effect of trypophobic stimulation on HR and HRV by comparing trypophobic individuals and healthy individuals. On the other hand, they did not examine the effect of the trypophobic stimulus category while comparing healthy and trypophobic individuals on the basis of HR, HRV, and EDA. Furthermore, we also believe that this is the first study to investigate the effect

of trypophobic stimulation on HRV utilizing frequency-domain and non-linear methods.

CHAPTER 2: METHOD

2.1. Participants

Considering the data of Le, Cole, and Wilkins (2020), 63 university students (15 male, 48 female) who were studying at Izmir University of Economics (M_{age}= *22.5* SD_{age}= *1.62*) participated in this study. The exclusion criteria of the study were summarized in table 1. The confirmation of participants in relation to not being diagnosed with any psychiatric disorders was conducted by a psychologist based on the Structured Clinical Interview for DSM-5 (SCID-5). All participants reported that they had normal or corrected to normal vision. All participants were informed about the experiment process, they were told that they could leave the experiment at any time, and they signed a written informed consent before the experiment started. The present study was approved by the ethics committee of Dokuz Eylul University (see Appendix A for Ethical Board Approval).

Table 1. The list of exclusion criteria of this thesis

Exclusion Criteria of Study
* Having any cardiovascular, cerebrovascular, rheumatic, endocrinological, or autoimmune disease that could lead to inflammatory changes.
* Having a cold in recent three days.
* Covid-19 vaccination in recent three days.
* Having been diagnosed with Covid-19 in the last month.
* Any known contact in the last week with someone diagnosed with Covid-19.
* Being diagnosed with any psychiatric disorder based on DSM-5 diagnostic criteria.
* Routine use of any medication.
* Being a smoker.
* Excessive caffeine use (more than 500 mg) in the last 12 hours.
* Alcohol or medication use in the last 12 hours.
* Intense physical activity in the last 12 hours.
* Having experienced a stressful event in the last 12 hours that may affect mood.

2.2. Materials

2.2.1. Demographic Form: This form includes questions regarding participants' age, sex, city, e-mail address, department, and education level. It was edited by the researcher himself. For an example of the form, see Appendix B.

2.2.2. Trypophobia Questionnaire Turkish Form: This scale was designed to assess the sensitivity of individuals to trypophobic stimuli taking into account the severity of symptoms they reported experiencing. The original version of the scale was first developed by Lee et al. (2015) and consisted of 19 items. Participants rate items on a 5-point Likert scale from 1 ("Not at all") to 5 ("Extremely") while looking at two commonly known trypophobic stimuli: lotus flower and honeycomb. The last two items on the scale are foil items; therefore, the subjects' total trypophobia score is calculated over the first 17 items. It was suggested in the original study that the total score of the first 17 items being 32 and above indicated that the person was likely to have trypophobia. The scale was adapted to the Turkish language by Yılmaz et al. (2020). Psychometric analysis revealed that the Turkish version of the questionnaire is valid and highly reliable (α =.96). For an example of the scale, see Appendix C.

2.3. Stimuli and Apparatus

2.3.1. Stimuli and Stimulus Presentation Program

In order to select the trypophobic stimuli to be presented in the experiment, first of all, 80 trypophobic images were found from different internet websites. While 40 of these images were skin-relevant stimuli, the other 40 were non-skin-relevant. Afterward, 69 students were asked to rate how much discomfort they experienced with each picture on a 5-point Likert scale from 1 ("Not discomforting at all") to 5 ("Extremely discomforting"). Rating of images was achieved by students on Google

Forms. Following this, a specific total score was obtained for each image by summing each participant's score for each image. In general, scores of skin-relevant stimuli (*M = 208.32, SE = 4.11*) was significantly higher than scores of non-skin-relevant stimuli (*M = 48.42, SE =2.79*), *t (39) = 98.709, p < .001*. This suggested that skin-relevant stimuli were more discomforting in comparison to non-skin-relevant stimuli for all participants. Following this, 40 images (20 skin-relevant stimuli and 20 non-skin-relevant stimuli) that were rated by participants as most discomforting were selected.

These images were presented in the experiment using OpenSesame 3.3.8 (Mathôt et al., 2012) via laptop computer (Lenovo PC 1 TB HDD/ 16 GB RAM / NVIDIA GeForce GTX 1050 2,2 GHz / 15.6-inch). All presented images were arranged in a way to have 512 x 512 pixels.

2.4. Procedure

Firstly, participants were handed out an informed consent form to ensure that they understood their participation was voluntary and that they could leave the experiment whenever they wanted to (For an example of the informed consent form, see Appendix D). Afterward, they were asked to fill out the demographic form and Turkish version of the Trypophobia Questionnaire. Participants who scored 32 or more on the scale were evaluated as trypophobic, while participants who scored below 32 were considered healthy. Following this, one Photoplethysmography (PPG) electrode was attached to the little finger of the participants' passive hand for pulse recording while two electrodes were attached to the index and middle fingers of the same hand for electrodermal activity (EDA) recording. After the attachment of the electrodes, PPG and EDA were recorded for 15 minutes. This 15-minute measurement stage was called the pre-experiment phase. Once the pre-experiment recording was completed, the recording was stopped, and the participants were

randomly assigned to one of the two experimental conditions: (1) skin group and (2) non-skin group. A description of the experiment was shown on the screen, and participants were asked to read this out. The description of the experiment was as follows:

"*During this experiment, you will be shown some images of trypophobic stimuli, one at a time, on the screen. Starting with the third stimulus, you will be presented with a question asking you to indicate whether the image you just saw on the screen and the image you saw 2 rows back are the same or not by pressing the appropriate key on the keyboard. You should try to answer as accurately as possible.*

If the image is the same, you need to press the "A" on the keyboard. However, if it is different, you need to press the "F" key. There will be a limited time for you to give your answer, and if you do not give your answers within this time frame, the next image will be displayed on the screen.

Before the experiment, there will be a practice phase. If you do not have any questions to ask the researcher, please press the spacebar to start the practice phase."

After ensuring that all questions of the participant regarding the experiment were answered, the experiment was started together with the electrophysiological recordings. During the experiment, 20 trypophobic images were presented randomly, 5 times each. All images were shown on the screen for 8000ms. A fixation dot that remained on the screen for 500ms preceded the presentation of each trypophobic image. As noted in the instructions, after the presentation of each stimulus (starting with the third stimulus), a question asking whether the current picture was the same or different from the picture they had viewed two rows back appeared on the screen. Each question remained on the screen for 4000ms, and participants had the chance to give their answers within this time frame. The goal of this task is to ensure that participants attended the presented images. Regardless of which participants

indicated their answer before/after the completion of 4000ms, a black blank screen followed the question and was shown on the screen for 3000ms.

After the completion of the experiment, the electrodes were removed, and participants were thanked for their participation. If participants had any question in relation to the experiment, it was clearly answered. The general procedure of the experiment for the skin-relevant condition and non-skin-relevant condition is shown in Figure 1 and Figure 2, respectively.

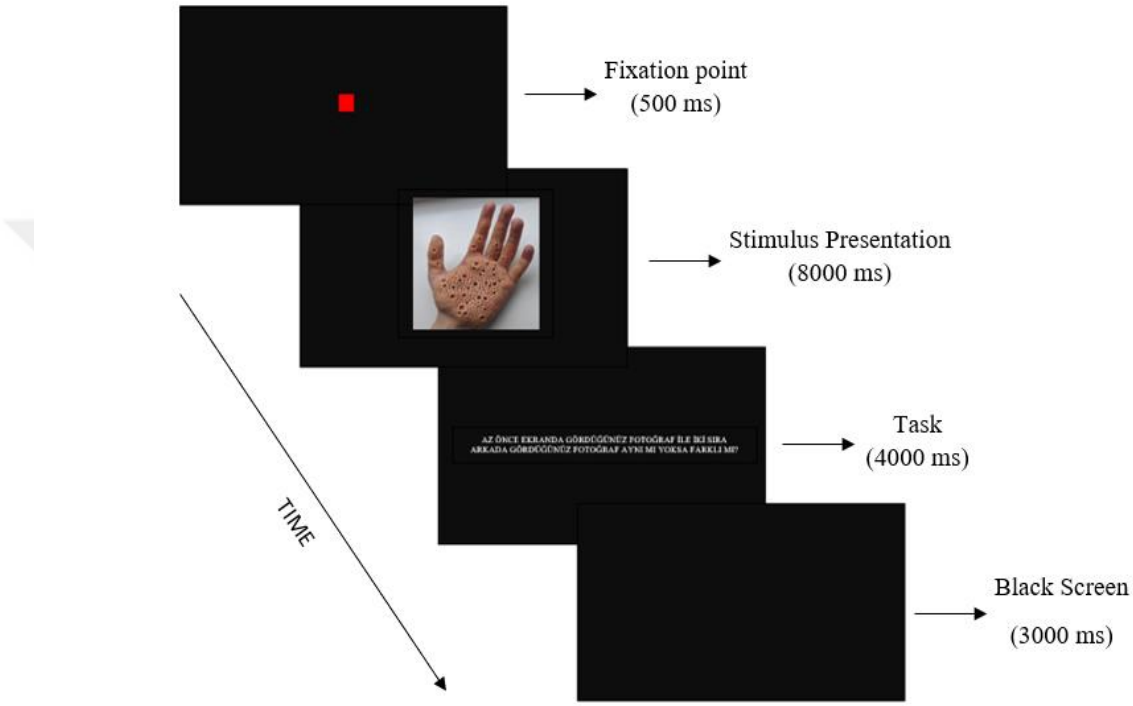

Figure 1. An illustration of the experimental procedure for the condition in which skin-relevant stimuli were used as experimental stimuli.

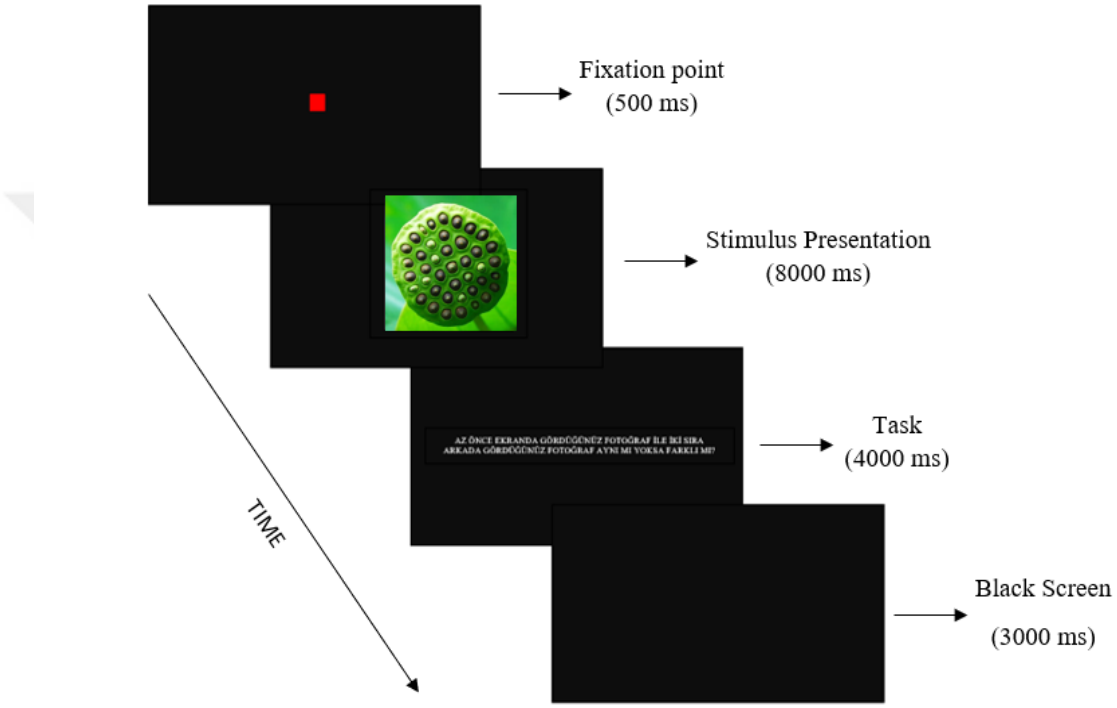

Figure 2. An illustration of the experimental procedure for the condition in which non-skin-relevant stimuli were used as experimental stimuli.

2.5. Acquisition of Data

2.5.1. Acquisition of HR and HRV Data

The analysis of HR and HRV data was first started with processing pulse recordings by means of ConsensysPRO (version 1.6.0, Consensys, Dublin, Ireland) Software which employed the Pan-Tompkins algorithm. This algorithm detects peak points (e.g., beat moments) in the measured biological signal and uses these points to form a sequence in which each peak point is arranged successively. The output of this process is R-R tachograms. If there are undetected parts in the R-R tachogram, missing signals are predicted based on the previous and next samples, a process called Berger Interpolation. This process allows us to predict the missed R-R intervals and obtain a stable R-R tachogram.

It was suggested that, in a given time series, HR can be estimated by multiplying the number of RR intervals that are obtained in a 10-second strip by six (Goldberger, 2002). On the other hand, HRV estimation can be accomplished via three distinct methods including time-domain, frequency-domain, and non-linear parameters (Shaffer and Ginsberg, 2017). Time-domain parameters function quite similarly to traditional methods used to calculate the variation in statistics and estimate the different types of variation in N-N intervals (Ernst, 2017a). N-N intervals differ from R-R intervals by not containing ectopic beats. Such beats are not generated by the sino-atrial (SA) node of the heart and so they are considered abnormal beats that may falsify the results (Citi, Brown, and Barbieri, 2012). In this study, the root mean square of successive R-R interval differences (RMSSD) was computed. RMSSD is the quantification of variation that arises from beat-to-beat fluctuations (Shaffer, McCraty, and Zerr, 2014). Because the parasympathetic activity is the main factor influencing beat-to-beat variation, RMSSD is hypothesized to reflect primarily the variation that arises as a result of parasympathetic activity (Shaffer and Ginsberg, 2017).

Frequency domain parameters give an estimate of how total power (e.g., total variance) is distributed over different frequency ranges (Malik, 1996). Calculation of frequency domain parameters requires time-domain R-R intervals first to be transformed into frequency domain through the use of Fast Fourier Transformation (FFT) (Ernst, 2017a). Afterward, power spectral density (PSD) analysis is employed to separate complex signals based on specific frequency ranges and then estimate the power of oscillations in each frequency range (Malik, 1996). In general, higher observed power within a certain frequency range indicates higher variation in HR. Furthermore, since different physiological processes take place at different rates, the resulting oscillations of these processes can be observed within different frequency ranges (Shaffer, McCraty, and Zerr, 2014). Thus, we can infer the possible processes playing a role in the fluctuation of heartbeats by means of frequency-domain measures. For example, parasympathetic activity usually shows its effect on HR instantaneously, and therefore observed high power at the High-frequency (HF) band is often seen as an indicator of predominant parasympathetic activity on heart rhythms during the measurement period (Ernst, 2017b). On the other hand, sympathetic activity produces its effect on HR slower than parasympathetic activity due to relevant cellular processes. Hence, the Low-frequency (LF) band is hypothesized to reflect predominantly sympathetic activity (Shaffer, McCraty, and Zerr, 2014). In HRV analysis, LF/HF ratio is commonly used to estimate sympathovagal balance (Malik, 1996). In particular, a higher ratio of LF/HF indicates increased sympathetic activity whereas a low ratio of LF/HF indicates decreased sympathetic activity. For this study, HRV data was interpreted through the HF-band parameter due to its close association with parasympathetic activity. Finally, in the estimation of frequency parameters, it is crucial to choose an appropriate sample rate to obtain clear and noise-free records (Ernst, 2017a). In our study, we determined a sampling rate of 128Hz.

Nonlinear parameters have been applied to HRV analysis more recently and estimate the unpredictability or complexity in recorded time series (Shaffer and Ginsberg, 2017). It is suggested that non-linear parameters characterize the dynamics of HRV more successfully in comparison to more conventional methods (e.g., frequency domain measurements) since chaotic fluctuations in heart rates are considered to be the result of the non-linear interaction of physiological processes with each other (de Godoy, 2016). In this study, we conducted a Detrended fluctuation analysis (DFA) as a non-linear method to investigate the self-similarity in recorded time series. Self-similarity is an index of how similar a subunit of R-R intervals is to a series of larger time scales (Goldberger et al., 2002). In DFA, the self-similarity of R-R intervals is calculated by initially taking cuts from HRV data and then estimating the correlations between each cut and the entire HRV record. The scale of cuts in DFA is determined depending on the focus of the study. In particular, small cuts (4-16 heartbeats) are needed if research investigates the self-similarity of rapid but brief fluctuations. On the other hand, a larger scale of cuts (16-64 heartbeats) is required if research investigates the self-similarity of slow but long fluctuations. In either case, a line is obtained by linking the points where each correlation values correspond. The slope of the line formed by linking short-term correlation values is expressed with α_1 whereas the slope of the other line formed by linking long-term correlation values is expressed with α_2. It is believed that the randomness between the R-R intervals increases as the alpha values approach 0.5 (Ernst, 2017b). On the other hand, as the alpha values approach 1.5, the R-R intervals are assumed to be highly correlated and thus to be quite similar to each other (Ernst, 2017b). It is suggested that a DFA-α_1 value reflects both sympathetic and vagal modulation (de Godoy, 2016), so for example, we can infer that a DFA-α_1 value close to 0.5 implies high irregularity in short-term fluctuations that arise possibly due to the activity of ANS.

In this study, Kubios HRV (version 2.0, Finland) free package program was used in the analysis of HR and all HRV parameters.

2.5.2. Acquisition of EDA Data

The analysis of EDA gives an estimation of how readily an external current can flow through the skin (Shaffer et al., 2016). Therefore, it is also known as the measurement of skin conductance. Traditionally, this is achieved by applying a minor electrical current between two electrodes placed on certain areas of the skin and measuring the level of conductance between these two points. In our study, the measurement of EDA signals was achieved via ConsensysPRO (version 1.6.0, Consensys, Dublin, Ireland) Software.

It is assumed that the EDA signal has two components: skin conductance level: SCL and skin conductance responses: SCRs (Benedek and Kaernbach, 2010). SCL is a type of tonic measure and reflects more general and lasting changes in EDA. On the other hand, SCRs reflect rapid and brief changes in EDA and have two types: event-related skin conductance responses (ER-SCRs) and non-specific skin conductance responses (NS-SCRs). ER-SCRs are reactions that develop in response to a particular stimulus whereas NS-SCRs may occur spontaneously without being associated with any eliciting stimulus. As a result of this, unlike to ER-SCRs which is an example of phasic activity in EDA, NS-SCRs are considered a type of tonic measure (Boucsein et al., 2012).

In our study, owing to the long presentation time of the stimuli, we have focused on tonic measurement of the electrodermal activity. In order to do this, the tonic component was first obtained from the overall EDA signal by means of a program that applies the cvxEDA algorithm (Greco et al., 2015) in Matlab 2021a (For an example of cvxEDA code, see Appendix D). This algorithm was built on a model that defines EDA as the aggregate of three terms: the phasic component, the tonic component, and an additive noise term consisting of measurement errors and

artifacts. Finally, to obtain the SCL index of the pre-experiment and experiment stages, we averaged signal values in the tonic component in relevant stages.

2.6. Experimental Design

In this research, 2 (Trypophobia sensitivity; trypophobic, non-trypophobic) x 2 (Category of trypophobic stimulus; skin-relevant, non-skin relevant) x 2 (Measurement stage: pre, during) mixed design was employed. Dependent measures of this experiment were heart rate (HR), vagal heart rate variability parameters (RMSSD, HF, DFA-α1), and electrodermal activity parameters (SCL).

CHAPTER 3: RESULTS

3.1. Pre-processing Stage

All statistical analysis was carried out with SPSS 20.0. Prior to the main statistical analysis, we first checked whether there were any missing parts in the recordings. It was determined that 10 participants' data had to be excluded due to incomplete recordings. Following this, the analysis was performed on the data of 53 participants (11 males). In this study, the normality of data was explored through skewness-kurtosis values and Shapiro–Wilk normality test. If skewness-kurtosis values were out of acceptable boundaries [-1, 1] and Shapiro–Wilk test result was significant ($p < .05$), we inferred that relevant data was non-normally distributed (Can, 2019).

3.2. The control of whether groups differed in terms of trypophobia sensitivity

Skewness-kurtosis values were inside of acceptable boundaries [-1, 1], and the Shapiro–Wilk test result was non-significant ($p > .05$). Therefore, we inferred that our data was normally distributed. Following this, we conducted an independent t-test analysis to test whether trypophobic and healthy individuals differed enough in respect of trypophobia sensitivity. Results indicated that the trypophobia score of the individuals we assigned as trypophobic ($M = 38.94$, $SE = 0.38$) was higher than the trypophobia score of the participants assigned as healthy ($M = 19.08$, $SE = 2.14$). This difference was significant ($t\ (15.98) = -9.124$, $p < .001$), and pointed out a large-sized effect ($r = .84$). The summary of the report's results is presented in Figure 3.

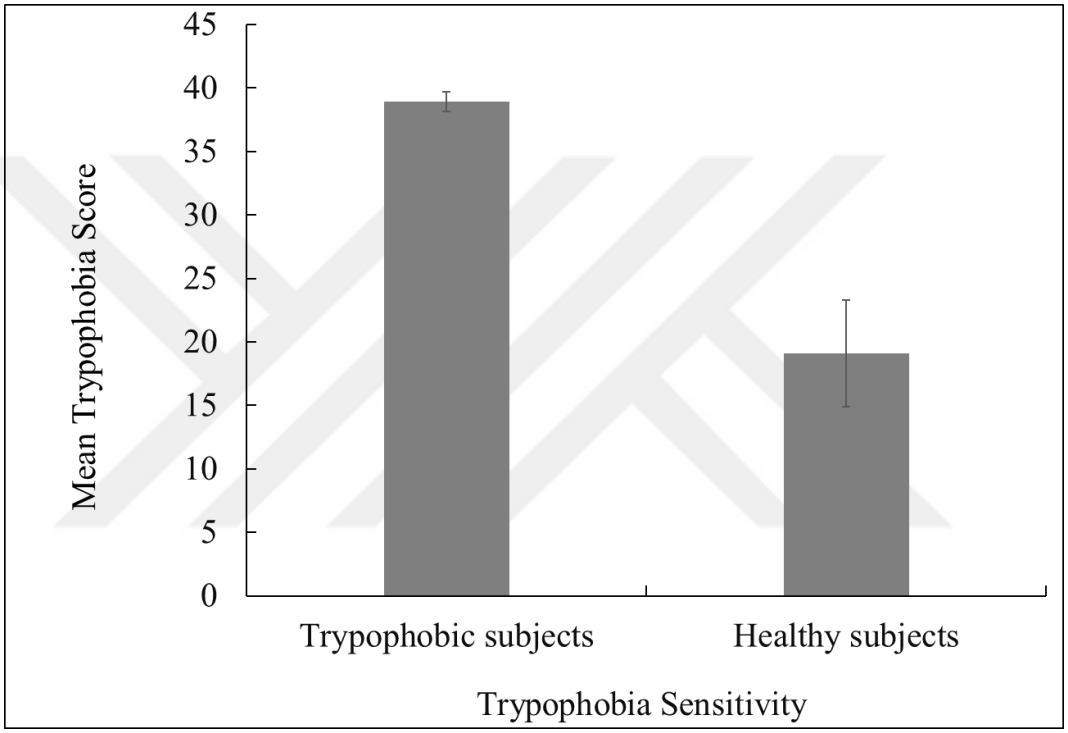

Figure 3. Mean (95% CI) trypophobia scores of the participants for trypophobia sensitivity.

3.3. The Effect of Trypophobia Sensitivity and Category of Trypophobic Stimulus on HR

Skewness-kurtosis values were inside of acceptable boundaries [-1, 1], and the Shapiro–Wilk test result was non-significant ($p > .05$). Therefore, we inferred that our data was normally distributed. Following this, a 2 (Trypophobia sensitivity: trypophobic, non-trypophobic) x 2 (Category of trypophobic stimulus: skin-relevant, non-skin relevant) x 2 (Measurement stage: pre, during) mixed ANOVA with repeated measures on the last factor was conducted on HR. Although HR was observed to decrease nearly across all conditions except the one in which non-trypophobic participants were presented with non-skin-relevant stimuli, the analysis revealed no significant effect.

3.4. The Effect of Trypophobia Sensitivity and Category of Trypophobic Stimulus on HRV Parameters

3.4.1. RMSSD

Skewness-kurtosis values were outside of acceptable boundaries [-1, 1], and Shapiro–Wilk test result was significant ($p > .05$), we inferred that our data were non-normally distributed and thus we took the logarithm of the data (Field, 2013). Following this, a 2 (Trypophobia sensitivity: trypophobic, non-trypophobic) x 2 (Category of trypophobic stimulus: skin-relevant, non-skin relevant) x 2 (Measurement stage: pre, during) mixed ANOVA with repeated measures on the last factor was conducted on RMSSD values.

It was found that the main effect of the measurement stage ($F_{(1,48)} = 4.776, p < .05, \eta^2 = .09$) was significant. Accordingly, in general, during the experiment RMSSD values ($M = 1.52, SE = 0.023$) were significantly higher than pre-experiment RMSSD values ($M = 1.49, SE = 0.025$). On the other hand, the RMSSD

values did not differ significantly based on trypophobia sensitivity and stimulus type. The summary of the report's results is presented in Figure 4.

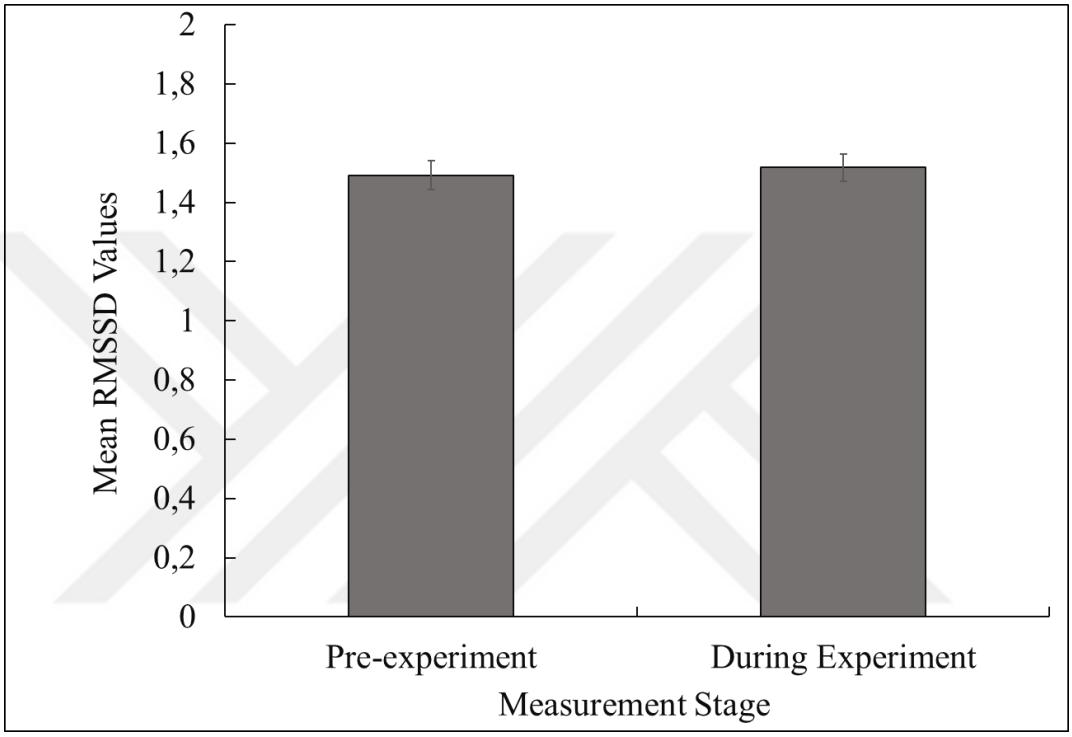

Figure 4. Mean (95% CI) RMSSD values of the participants for measurement stages.

3.4.2. High-frequency (HF) Band

Skewness-kurtosis values were outside of acceptable boundaries [-1, 1], and Shapiro–Wilk test result was significant ($p > .05$), we inferred that our data were non-normally distributed and thus we took the logarithm of the data (Field, 2013). Following this, a 2 (Trypophobia sensitivity: trypophobic, non-trypophobic) x 2 (Category of trypophobic stimulus: skin-relevant, non-skin relevant) x 2 (Measurement stage: pre, during) mixed ANOVA with repeated measures on the last factor was conducted on HF values.

It was found that the main effect of the measurement stage ($F_{(1,48)} = 11.929$, $p < .001$, $\eta^2 = .20$) was significant. Accordingly, in general, during the experiment HF values ($M = 2.70$, $SE = .04$) was significantly higher than pre-experiment HF values ($M = 2.60$, $SE = .05$). On the other hand, the HF values did not differ significantly based on trypophobia sensitivity and stimulus type. The summary of the report's results is presented in Figure 5.

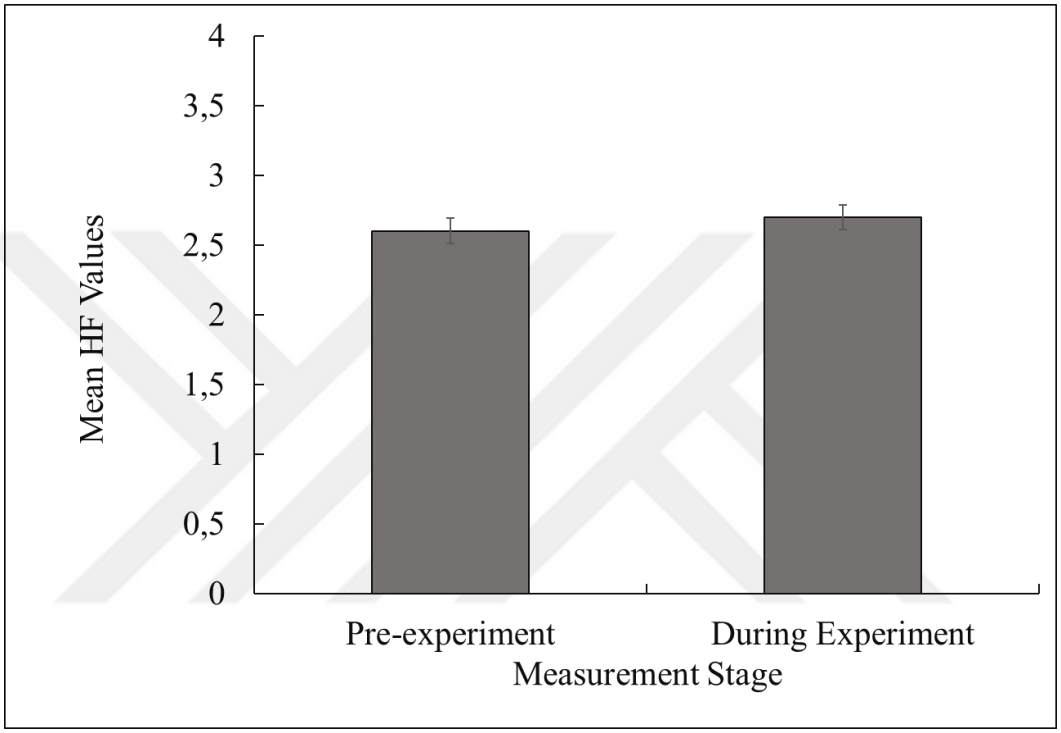

Figure 5. Mean (95% CI) HF values of the participants for measurement stages.

3.4.3. DFA-α1

Skewness-kurtosis values were inside of acceptable boundaries [-1, 1], and Shapiro–Wilk test result was non-significant ($p > .05$). Therefore, we inferred that our data was normally distributed. Following this, a 2 (Trypophobia sensitivity: trypophobic, non-trypophobic) x 2 (Category of trypophobic stimulus: skin-relevant, non-skin relevant) x 2 (Measurement stage: pre, during) mixed ANOVA with repeated measures on the last factor was conducted on DFA-α1 values.

It was found that main effect of measurement stage ($F_{(1,48)} = 9.128, p < .01, \eta^2 = .16$) was significant. Accordingly, in general, pre-experiment DFA-α1 values ($M = 1.30, SE = .03$) were significantly higher than during experiment DFA-α1 values ($M = 1.23, SE = .03$). On the other hand, the DFA-α1 values did not differ significantly based on trypophobia sensitivity and stimulus type. The summary of the report's results is presented in Figure 6.

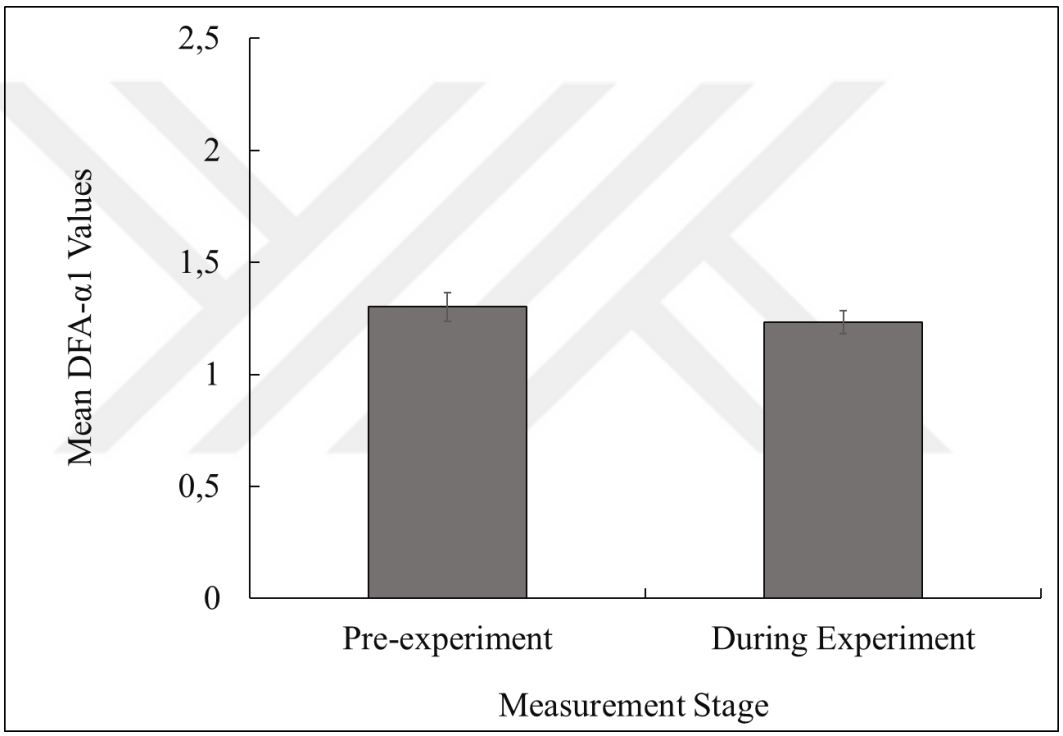

Figure 6. Mean (95% CI) DFA-α1 values of the participants for measurement stages.

3.5. The Effect of Trypophobia Sensitivity and Category of Trypophobic Stimulus on EDA

Since Skewness-kurtosis values were inside of acceptable boundaries [-1, 1], and the Shapiro–Wilk test result was non-significant ($p > .05$), we inferred that our data were normally distributed. Furthermore, since the tonic component of EDA is affected by a variety of internal and external variables (e.g., culture), it is often the case that basal values of EDA may vary substantially between subjects independent of experimental manipulation (Boucsein et al., 2012). To avoid this, a common procedure in tonic EDA analysis is to subtract conditions from each other (Li et al., 2022). Following this, we subtracted the mean SCL value of the pre-experimental phase the from mean SCL value of the experimental phase. Then, a 2 (Trypophobia sensitivity: trypophobic, non-trypophobic) x 2 (Category of trypophobic stimulus: skin-relevant, non-skin relevant) two-way independent ANOVA was conducted on values obtained from subtraction.

Results revealed that the main effect of stimulus type ($F_{(1,49)} = 5.034$, $p < .05$, $\eta^2 = .09$) was significant. Accordingly, in conditions in which skin-relevant stimuli ($M = .10$, $SE = .03$) were presented, the increase of SCL values was greater in comparison to conditions in which non-skin-relevant stimuli ($M = .01$, $SE = .03$) were presented. On the other hand, the increase of SCL values did not differ significantly based on trypophobia sensitivity. The summary of the report's results is presented in Figure 7.

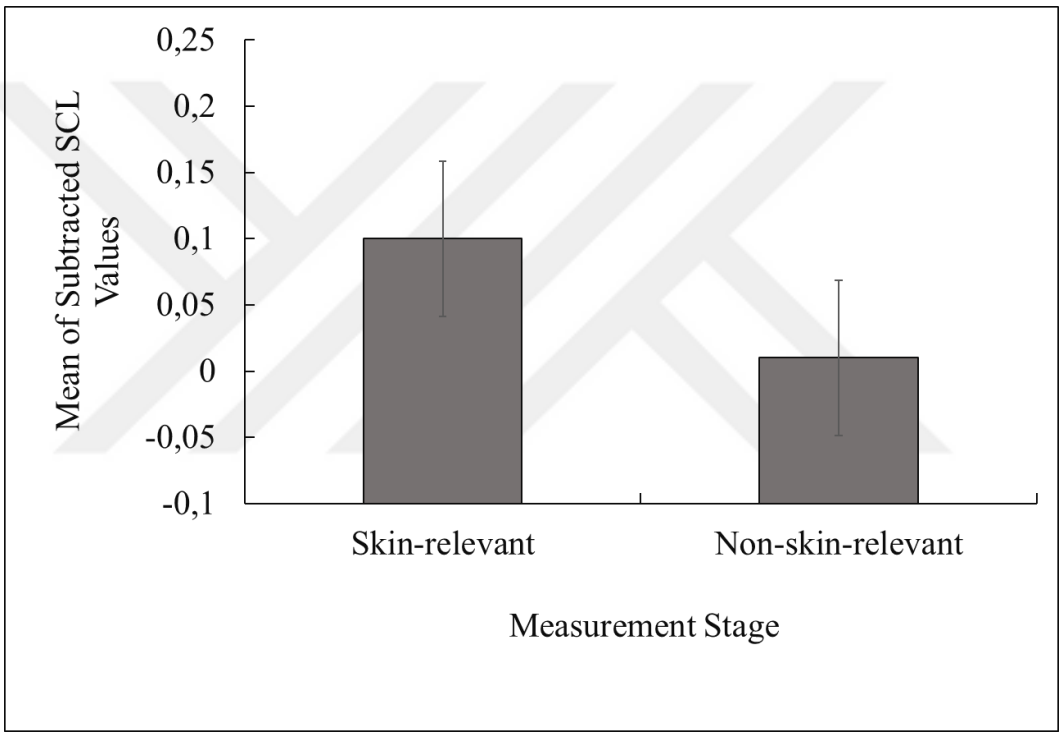

Figure 7. Mean (95% CI) subtracted SCL values of the participants for measurement stages.

CHAPTER 4: DISCUSSION

As noted previously, in this thesis, we tried to examine the effect of trypophobia sensitivity and trypophobic stimulus category on a range of physiological variables including HR, HRV, and EDA. We also tried to examine whether there is an interaction effect between trypophobia sensitivity and the trypophobic stimulus category on the basis of recorded physiological variables. Here, we first obtained baseline HR, HRV, and EDA measures of participants, and then we recorded the same parameters during trypophobic stimulation. Trypophobic stimulation was achieved either through exposure to skin-relevant stimuli or non-skin-relevant stimuli. Furthermore, prior to the experiment, participants were separated into two groups (trypophobic, non-trypophobic) based on their scores on the trypophobia scale.

Our results suggested that vagally-mediated HRV, regardless of trypophobic sensitivity and trypophobic stimulus category, was higher during the experiment compared to pre- experimental stage. However, contrary to our predictions, we found no significant differentiation in HR, HRV, and EDA based on trypophobic sensitivity. Furthermore, we also did not find an effect of the trypophobic stimulus category on HR and HRV. Finally, clinical and healthy individuals did not differ in HR, HRV, and EDA depending on whether trypophobic stimulation was achieved through skin-relevant stimuli or non-skin-relevant stimuli. On the other hand, our results suggested that skin-relevant stimuli, in general, led to a greater increase in EDA compared to non-skin-relevant stimuli. Thus, only our second hypothesis found partial support in our findings while our first hypothesis was rejected completely. This section intended to discuss the findings obtained through conducted experiment.

4.1. Heart Rate (HR) and Heart Rate Variability (HRV) Findings

Previous studies provided confusing findings in relation to the cardiovascular basis of trypophobia. In an earlier study, Le, Cole, and Wilkins (2020) showed that HR and vagally mediated HRV parameters (RMSSD) were higher during exposure to trypophobic images; however, this effect was only observed in trypophobic individuals. On the other hand, Pipitone, Gallegos, and Walters, (2017) found no effect of trypophobic stimulation on HR. Pipitone, Gallegos, and Walters, (2017) also reported that there was no correlation between the changes in heart rate during trypophobic stimulation and the trypophobia score.

We would like to note that the structure of our study differed from Le, Cole, and Wilkins (2020) in several aspects. For instance, we tried to obtain a pulse recording as clearly as possible by excluding participants with features (e.g., smoking) that may have a confounding effect on cardiovascular system parameters (Harte and Meston, 2014). Furthermore, in addition to time-domain parameters, we investigated the effect of experimental manipulation on HRV through different methods including frequency-domain parameters and non-linear parameters. Thus, we were able to more thoroughly examine the possible effects that may arise on the basis of HRV during the experiment.

Contrary to the findings of Le, Cole, and Wilkins (2020), during trypophobic stimulation, our results revealed no differentiation between trypophobic and healthy subjects on the basis of HR and HRV. Additionally, this result also did not change depending on whether the trypophobic stimulation was accomplished through skin-related stimuli or non-skin-related stimuli. We also found no distinct effect of the stimulus category on HR and HRV, although EDA was higher during exposure to skin-relevant stimuli compared to non-skin-relevant stimuli. Thus, these results indicate that trypophobia sensitivity and trypophobic stimulus category had no

distinct and combined effect on the change of HR and vagally mediated HRV during the experiment. In the following part of this section, we will discuss the possible reasons why trypophobia sensitivity and stimulus type did not have a significant effect on HR and HRV in our study.

It can be suggested that one possible reason underlying the non-significant result may be the use of a cut-off point through the trypophobia scale when determining whether or not participants had trypophobia. One disadvantage of this method is that participants who score slightly above the cut-off point are considered trypophobic, while those who score slightly below the cut-off point are considered non-trypophobic. Given that, in our study, a substantial portion of the participants who were evaluated as trypophobic had a score between 30 and 40 (cut-off point = 32), the reason for the lack of a significant effect may be that the groups did not differ from each other enough in terms of trypophobia sensitivity. However, our results indicated that the trypophobia score of participants with trypophobia was significantly higher than the trypophobia score of healthy participants. Thus, the lack of significant effect is not likely to be a product of using the cut-off score in determining if individuals had trypophobia.

Another reason for the absence of significant change in HR and HRV during trypophobic stimulation may be that the type of disgust experienced against trypophobic stimuli differs from the types of disgust described by Kreibig (2010). As we noted before, Kreibig (2010) categorized disgust forms as contamination disgust and mutilation disgust. Considering that trypophobic stimuli show similarity to infectious disease symptoms on the skin, we predicted that the experience of disgust would lead to an increase in HR and HRV similar to other contamination disgust elicitors. However, some researchers suggested categorizing disgust domains in different ways. For example, Rozin, Haidt, and McCauley (2000) argued that disgust emotion has qualitatively four different domains: core disgust, interpersonal disgust,

animal-reminder disgust, and moral disgust. Core disgust refers to the experience of disgust in response to objects (e.g., spoiled foods) that can be harmful to the body following oral ingestion. Interpersonal disgust refers to the type of disgust experience that is evoked in response to direct or indirect contact (e.g., using someone else's toothbrush) with individuals who are infected, unknown, and had the misfortune (e.g., amputated leg). Animal-reminder disgust is elicited by stimuli (e.g., dead bodies) that likely remind humans they are mortal animals. Lastly, moral disgust is experienced against violators of social norms (e.g., rapists). Differently, by taking a more adaptationist perspective, Tybur, Lieberman, and Griskevicius (2009) argued that disgust emotion has three types: pathogen disgust, moral disgust, and sexual disgust. In this approach, pathogen disgust is experienced in response to all infection sources; sexual disgust is experienced in response to partners with low intrinsic quality (i.e., physical attractiveness) and high genetic similarity (e.g., relatives); moral disgust is experienced in response to those who violate social norms. Considering that there is no consensus in the literature concerning the types of disgust, there may be different forms of disgust that were not described by Kreibig (2010), and trypophobic stimuli may trigger one of these forms of disgust. This idea found support in a study (Blake et al., 2017) that showed trypophobic stimuli led to distinct behavioral responses from common contamination disgust elicitors (e.g., rotten foods). In particular, in this study, contamination disgust elicitors (e.g., rotten foods) were found to trigger a feeling of nausea and vomiting whereas trypophobic stimuli alongside skin-transmitted pathogens (e.g., lice) were found to trigger hair-raising sensations and itchiness. Thus, it may be that trypophobic stimuli induce a type of disgust response that differs from contamination disgust, and this disgust form may be characterized by skin-related responses at the behavioral level and no change in HR and HRV at the physiological level.

We believe that one further reason underlying the lack of significant change in HR and HRV may be the use of a visual 2-back task in the experiment. Referencing Stevenson et al. (2011), we decided to use this task to ensure

participants have given their full attention to the presented images. This task required participants to judge whether the current image matched the one presented 2 steps before in the sequence. While there are different versions of the 2-back task, it should be noted that all versions require the use of a working memory function, which mainly involves retaining information and working on it mentally (Diamond, 2013). Recently, a number of studies showed that increases in vagally-mediated HRV parameters were closely related to the employment of executive functions (Park and Thayer, 2014). For instance, in one study, vagally-mediated HRV parameters (RMSSD) were found to be higher during a high self-control task compared to a low self-control task (Segerstrom and Nes, 2007). Furthermore, compared to control subjects, vagally mediated HRV parameters enhanced more substantially for ones who were asked to regulate their emotions through either suppression or reappraisal (Butler, Wilhelm, and Gross, 2006). The close relationship between performing emotional regulation and heightened HRV found also support at the neural level such that the activity of the subgenual anterior cingulate cortex (a region linked with emotion regulation) was positively correlated with values of HRV parameters (Lane et al., 2013). Given that the working memory function is assumed to be an executive process and closely related to the activation of frontal cortex areas (Lara and Wallis, 2015), the use of the n-back task which employs working memory may have affected our results negatively. In particular, due to the low level of aversion and discomfort experienced by the healthy subjects, the working memory function may have been employed more effectively in healthy individuals than in trypophobic individuals. This may have heightened the vagal HRV in healthy subjects and thus reduced the differences between trypophobic and healthy participants in terms of vagal HRV parameters. Although we are aware that this explanation is highly speculative, the fact that vagally-mediated HRV, in general, was significantly higher during the experiment compared to the pre-measurement stage motivated us to think that in addition to disgust experience, another effect may have also heightened vagal HRV parameters during the experiment.

Finally, the lack of a significant effect may be also due to the relatively small number of participants included in the analysis. It is well-known in statistics that small samples, compared to large samples, have comparatively less power to detect significant effects due to their high standard error (Field, 2013). Following this, a conclusion is that large differences between experimental groups may not be considered significant when the sample size is small. Thus, in this study, one interpretation is that the analysis result might have been significant if we had conducted this experiment with a larger sample. This idea may find support in the fact that the differences between the groups in our study were in the predicted direction.

4.2. Electrodermal Activity (EDA) Findings

Previously, Pipitone, Gallegos, and Walters, (2017) showed that both tonic and phasic components of EDA were higher during exposure to trypophobic images compared with control images. Here, trypophobic stimulation was achieved through non-skin-relevant stimulus, and participants' trypophobia score was not considered. Differently, in our study, we investigated trypophobic stimuli under two categories as skin-relevant and non-skin-relevant, and we grouped individuals based on their score on the trypophobia scale as healthy and trypophobic.

The finding that skin-relevant stimuli led to a greater increase in tonic EDA than non-skin-relevant stimuli did is in accordance with the findings of prior studies. It was shown in several studies that skin-relevant stimuli were found more aversive by both healthy and clinical subjects in comparison to non-skin-relevant stimuli (Furuno et al., 2018; Furuno et al., 2017; Kupfer and Le, 2017). According to Kupfer and Le (2017), skin-relevant stimuli are more aversive for subjects since this category of trypophobic stimulus shows a greater degree of resemblance to infectious disease symptoms (e.g., smallpox) compared to non-skin-relevant stimuli. Infectious

disease symptoms are among the well-known triggers of disgust which is closely associated with heightened EDA (Oaten, Stevenson, and Case, 2009). Following this, it can be predicted that skin-related stimuli would lead to higher EDA than non-skin-related stimuli, and this idea was confirmed in our study. Considering the close relationship of heightened EDA with sympathetic nervous system activation (Critchley, 2002), based on these findings, we can infer that skin-relevant trypophobic stimuli activate the sympathetic branch of the autonomic nervous system more strongly than non-skin-related stimuli. Thus, the idea that skin-relevant stimuli are more aversive for subjects than non-skin-relevant stimuli has found support in our study at the physiological level.

On the other hand, our findings revealed no difference between clinical and healthy subjects on the basis of tonic EDA during trypophobic stimulation. Moreover, this effect did not show differentiation based on the type of presented trypophobic stimulus. Earlier studies suggested that individuals with high trypophobia scores experienced higher levels of disgust towards trypophobic stimuli compared to those with low trypophobia scores (Kupfer ve Le, 2017; Imaizumi et al., 2016). Considering that there is a close relationship between disgust experience and heightened EDA (Kreibig, 2010), we expected to observe a higher increase in EDA recorded from participants with trypophobia compared to healthy subjects during trypophobic stimulation. We believe that one possible reason why trypophobic and healthy individuals may not have differed on the basis of EDA during trypophobic stimulation may be the small number of participants included in the analysis. This idea may find support in the fact that the differences between the groups in our study were in the predicted direction. However, since we already discussed the possible detrimental effects of the small sample size on analysis results in the previous section, we did not discuss them further in this part.

4.3. Limitations and Conclusion

In the discussion part, we focused on generally possible reasons why our groups did not differ from each other, contrary to our predictions in our hypotheses. Apart from this, we have also discussed our findings indicating that skin-relevant stimuli led to a greater increase in tonic EDA compared to non-skin-relevant stimuli. As we noted, this result is the first physiological evidence to demonstrate that skin-relevant stimuli, in general, are more aversive for individuals compared to non-skin-relevant stimuli.

It should be noted that our study has several limitations. For instance, as we discussed in previous parts, our sample size in this thesis is relatively small. Secondly, as experimental stimuli, we have only exposed participants to types of trypophobic stimuli. However, the influence of trypophobic stimuli on physiological processes could have been better studied if neutral stimuli were used as experimental stimuli, in addition to forms of trypophobic stimuli. Furthermore, the use of a visual 2-back task during the experiment is another limitation of this study since its use may have affected experiment results negatively by increasing vagal HRV parameters in healthy subjects independent of experimental manipulation.

In conclusion, this study provided partial physiological evidence for which skin-relevant stimuli were more aversive for subjects compared to non-skin-relevant stimuli by showing that skin-relevant stimuli led to a greater change in EDA compared to non-skin-relevant stimuli. However, no evidence was found for the effect of trypophobic sensitivity on HR, HRV, and EDA.

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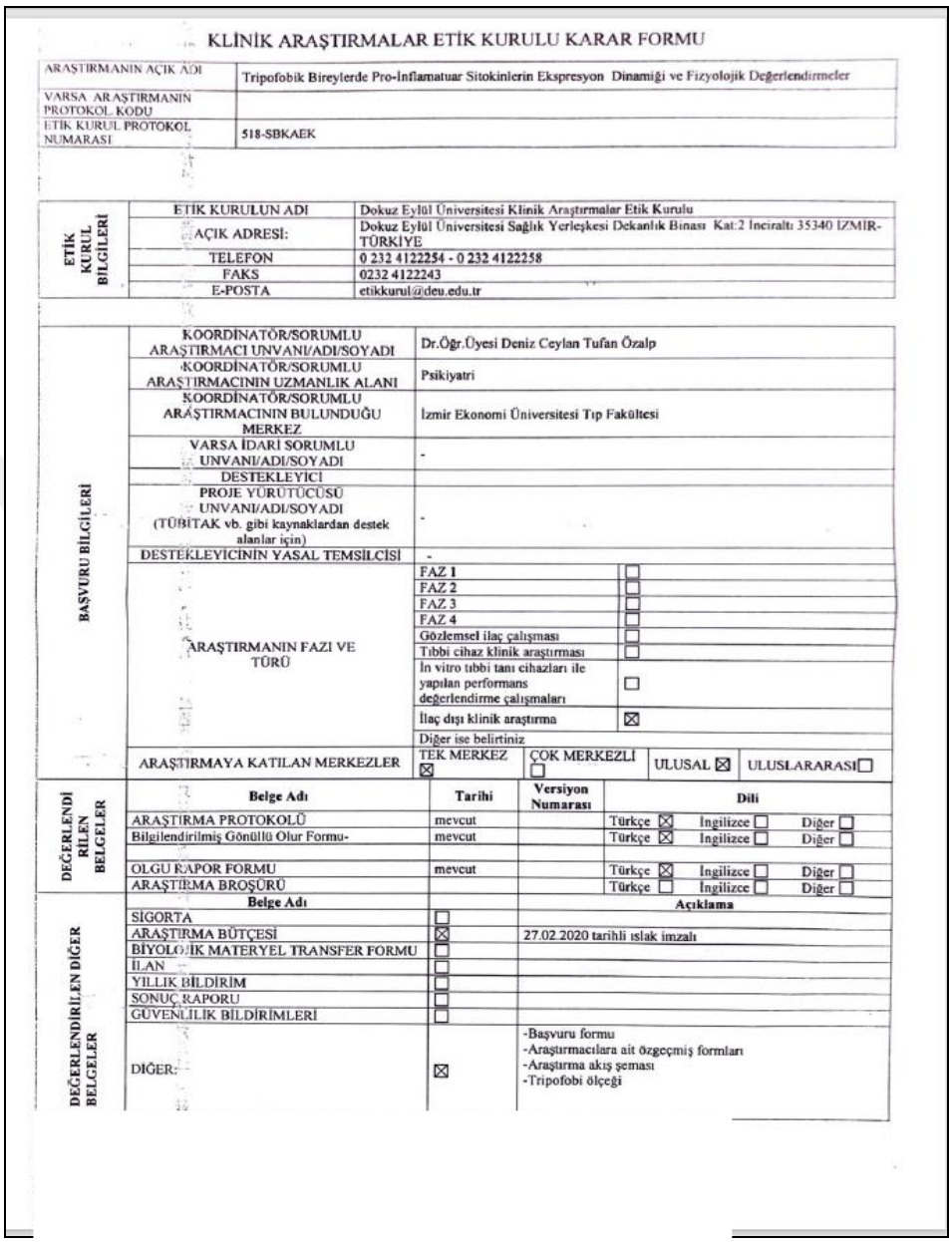
APPENDICES

Appendix A – Ethical Board Approval



KLİNİK ARAŞTIRMALAR ETİK KURULU KARAR FORMU

ARAŞTIRMANIN AÇIK ADI	Tripofobik Bireylerde Pro-İnflamatuar Sitokinlerin Ekspresyon Dinamiği ve Fizyolojik Değerlendirmeler
VARSA ARAŞTIRMANIN PROTOKOL KODU	
ETİK KURUL PROTOKOL NUMARASI	518-SBKAEK

ETİK KURUL BİLGİLERİ		
	ETİK KURULUN ADI	Dokuz Eylül Üniversitesi Klinik Araştırmalar Etik Kurulu
	AÇIK ADRESİ:	Dokuz Eylül Üniversitesi Sağlık Yerleşkesi Dekanlık Binası Kat:2 İnciraltı 35340 İZMİR-TÜRKİYE
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	KOORDİNATÖR/SORUMLU ARAŞTIRMACI UNVANI/ADI/SOYADI	Dr.Öğr.Üyesi Deniz Ceylan Tufan Özalp
	KOORDİNATÖR/SORUMLU ARAŞTIRMACININ UZMANLIK ALANI	Psikiyatri
	KOORDİNATÖR/SORUMLU ARAŞTIRMACININ BULUNDUĞU MERKEZ	İzmir Ekonomi Üniversitesi Tıp Fakültesi
	VARSA İDARİ SORUMLU UNVANI/ADI/SOYADI	-
	DESTEKLEYİCİ	
	PROJE YÜRÜTÜCÜSÜ UNVANI/ADI/SOYADI (TÜBİTAK vb. gibi kaynaklardan destek alanlar için)	-
	DESTEKLEYİCİNİN YASAL TEMSİLCİSİ	-
	ARAŞTIRMANIN FAZI VE TÜRÜ	FAZ 1 ☐ FAZ 2 ☐ FAZ 3 ☐ FAZ 4 ☐ Gözlemsel ilaç çalışması ☐ Tıbbi cihaz klinik araştırması ☐ İn vitro tıbbi tanı cihazları ile yapılan performans değerlendirme çalışmaları ☐ İlaç dışı klinik araştırma ☒ Diğer ise belirtiniz
	ARAŞTIRMAYA KATILAN MERKEZLER	TEK MERKEZ ☒ ÇOK MERKEZLİ ☐ ULUSAL ☒ ULUSLARARASI ☐

DEĞERLENDİRİLEN BELGELER	Belge Adı	Tarihi	Versiyon Numarası	Dili
	ARAŞTIRMA PROTOKOLÜ	mevcut		Türkçe ☒ İngilizce ☐ Diğer ☐
	Bilgilendirilmiş Gönüllü Olur Formu-	mevcut		Türkçe ☒ İngilizce ☐ Diğer ☐
	OLGU RAPOR FORMU	mevcut		Türkçe ☒ İngilizce ☐ Diğer ☐
	ARAŞTIRMA BROŞÜRÜ			Türkçe ☐ İngilizce ☐ Diğer ☐

DEĞERLENDİRİLEN DİĞER BELGELER	Belge Adı		Açıklama
	SİGORTA	☐	
	ARAŞTIRMA BÜTÇESİ	☒	27.02.2020 tarihli ıslak imzalı
	BİYOLOJİK MATERYEL TRANSFER FORMU	☐	
	İLAN	☐	
	YILLIK BİLDİRİM	☐	
	SONUÇ RAPORU	☐	
	GÜVENLİLİK BİLDİRİMLERİ	☐	
	DİĞER:	☒	-Başvuru formu -Araştırmacılara ait özgeçmiş formları -Araştırma akış şeması -Tripofobi ölçeği

Appendix B – Demographic Form

KATILIMCI BİLGİ FORMU

Adınız Soyadınız:

_____

Cinsiyet: Kadın ( ) Erkek ( ) Diğer ( )

Yaş: _____.

E-mail adresiniz

_____

Eğitim Durumunuz (en son mezun olduğunuz okulu düşünerek):
( ) İlkokul
( ) Ortaokul
( ) Lise
( ) Lisans
( ) Yüksek Lisans
( ) Doktora

Okuduğunuz Bölüm:

_____

Son 3 gün içerisinde Covid-19 aşısı yaptırdınız mı?
Evet ( ) Hayır ( )

Son 1 ay içerisinde Covid-19 tanısı aldınız mı?
Evet ( ) Hayır ( )

Sigara Kullanıyor musunuz?
Evet ( ) Hayır ( )

Son 12 Saatte alkol kullandınız mı?
Evet ( ) Hayır ( )

Son 12 saatte ağır fiziksel aktivitede (antrenman vs.) bulundunuz mu?
Evet ( ) Hayır ( )

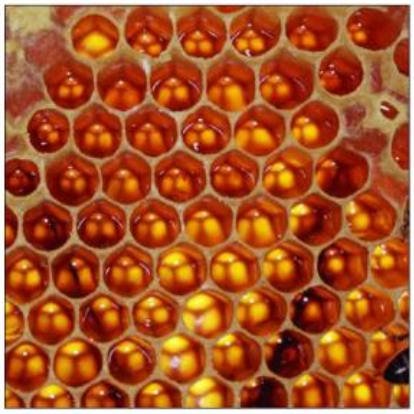
Herhangi bir kronik rahatsızlığınız var mı?
Evet ( ) Hayır ( )

Son 12 saatte aşırı kafein (yaklaşık 10 fincan türk kahvesi) aldınız mı?
Evet ( ) Hayır ( )

Son 12 saatte duygu durumunuzu derinden etkileyebilecek bir olay yaşadınız mı?
Evet ( ) Hayır ( )

Appendix C – Trypophobia Questionnaire Turkish Form

TRİPOFOBİ ÖLÇEĞİ



Yukarıda gördüğünüz fotoğraflara bakmak size aşağıda verilen duygu veya durumları hangi şiddette hissetiriyor? Lütfen uygun bir biçimde işaretleyiniz.

Sorular	Hiç	Biraz	Orta	Çok	Aşırı
1. Kontrolümü kaybetmiş hissediyorum.					
2. Hoşnutsuzluk, tiksinti ya da uzak durma ihtiyacı hissediyorum.					
3. Rahatsız ya da tedirgin hissediyorum					
4. Panik yapıyorum ya da çığlık atıyorum					

5. Kaygılı, dehşet dolu veya ürkmüş hissediyorum.					
6. Fenalık hissi ya da mide bulantısı yaşıyorum					
7. Gergin hissediyorum (örn: kalbimde sıkışıklık var, midemde kelebekler uçuşuyor, terliyorum, karnım ağrıyor vb).					
8. Çıldıracak gibi hissediyorum.					
9. Delik görüntülerini tahrip etme/ bozma dürtüsü yaşıyorum.					
10. Kaşıntı hissediyorum.					
11. Cildimde karıncalanma hissediyorum.					
12. Huzur bulmuş hissediyorum					
13. Tüylerim diken diken oluyor.					
14. Ürperiyorum.					
15. Ağlayacakmış gibi hissediyorum.					

16. Kusasım geliyor ya da öğürüyorum.					
17. Nefes alırken zorlanıyorum.					

Appendix D – Informed Consent Form

SAYIN KATILIMCI,

Genel olarak, "delik korkusu" olarak tanımlanmış tripofobinin, vücudun bağışıklık sistemi ile ilişkilendirilebilecek süreçleri tetiklediğine yönelik bulgular ortaya konmuştur. Bu araştırmanın amacı tripofobik uyaranların bağışıklık sistemi, kardiyovasküler sistem ve elektrodermal aktivite üzerindeki etkisini araştırmaktır. Bu çalışma kapsamında size herhangi bir ilaç uygulaması yapılmayacaktır. Tripofobinin bağışıklık sistemi üzerindeki etkisini araştırmak üzere deney öncesi ve sonrasında 15 cc kan örneğiniz alınacak ve vücut sıcaklığınız ölçülecektir. Bu işlemin kan alınması dışında sizin üzerinizde hiçbir etkisi olmayacaktır. Kan alınması sırasında en sık görülen yan etkiler, kolunuzda iğne yerinde ağrı ve morarmadır. Tripofobik uyaranların kardiyovasküler sistem ve elektrodermal aktivite üzerindeki etkisi ise pasif el parmaklarınıza yerleştirilecek olan elektrotlar aracılığıyla incelenecektir.

Bu araştırmanın sonuçları yalnızca bilimsel amaçlarla kullanılacak, veriler ve size ait bilgiler gizli tutulacaktır. Yerel Etik Kurulların ve T.C. Sağlık Bakanlığı'nın gerek gördüğü durumlarda kayıtlarınız bu kurumlara açık olacaktır. Bu formun imzalanmasıyla bu erişime izin vermiş olacaksınız. Kimliğinizi ortaya çıkaracak kayıtlar kesinlikle gizli tutulacak, kamuoyuna açıklanmayacaktır. Araştırma sonuçlarının yayımlanması halinde dahi kimliğiniz gizli kalacaktır. Araştırma konusuyla ilgili ve sizin araştırmaya devam etme isteğinizi etkileyebilecek yeni bilgiler elde edildiğinde zamanında bilgilendirileceksiniz. Araştırmayla ilgili herhangi bir sorunuzu veya sorununuzu numaralı telefondan Proje Asistanı Süleyman Öztürk'e ya da · numaralı telefondan proje sorumlusu Burak Erdeniz'e danışabilirsiniz. Bu çalışma sırasında uygulanacak testlerin ve araştırma ile ilgili gerçekleştirilecek diğer işlemlerin masrafları size veya güvencesi altında bulunduğunuz resmi ya da özel hiçbir kurum veya kuruluşa ödetilmeyecektir. Bu çalışmanın tümüne ya da bir kısmına katılmayı reddetme ya da araştırma başladıktan sonra devam etmeme hakkına sahipsiniz. Bu çalışmaya katılmanız veya başladıktan sonra herhangi bir aşamasında ayrılmanız daha sonraki tıbbi bakımınızı etkilemeyecektir. Araştırmacı da gönüllünün kendi rızasına bakmadan, gereklilik ortaya çıkarsa olguyu araştırma dışı bırakabilir.

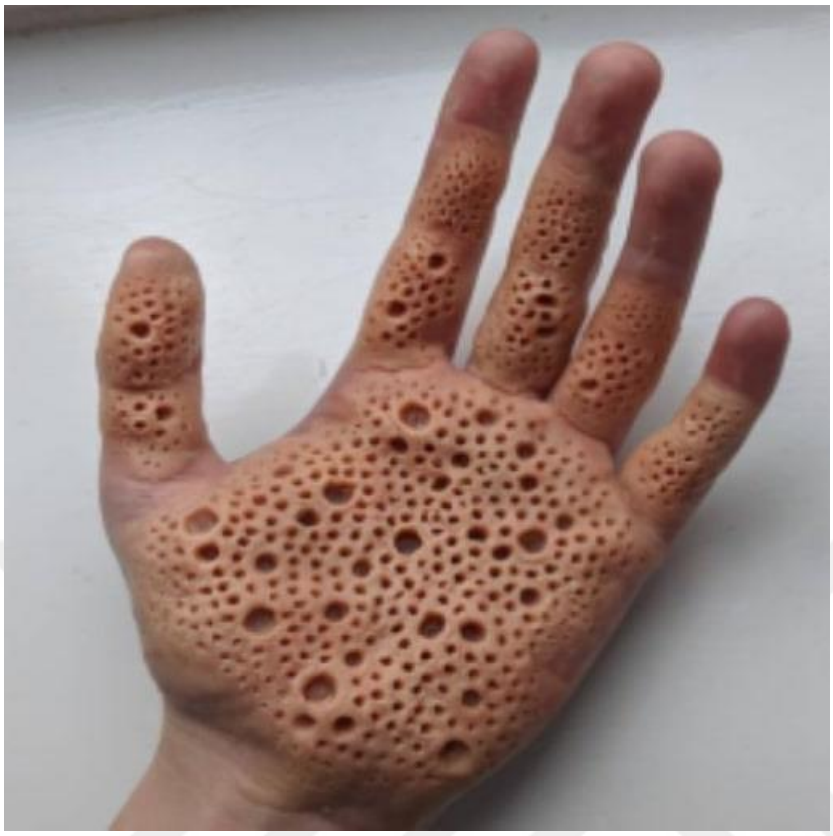
Yukarıda yer alan ve araştırmadan önce gönüllüye verilmesi gereken bilgileri gösteren Bilgilendirilmiş Onam Formunu okudum ya da bana okunmasını sağladım. Bu bilgilerin içeriği ve anlamı, yazılı ve sözlü olarak açıklandı. Aklıma gelen bütün soruları sorma olanağı tanındı ve sorularıma yeterli cevaplar aldım. Çalışmaya katılmadığım ya da katıldıktan sonra çekildiğim durumda, hiçbir yasal hakkımdan vazgeçmiş olmayacağım. Bu koşullarla, söz konusu araştırmaya hiçbir baskı ve zorlama olmaksızın gönüllü olarak katılmayı kabul ediyorum.

Katılımcının (Kendi el yazısı ile)
İmzası:

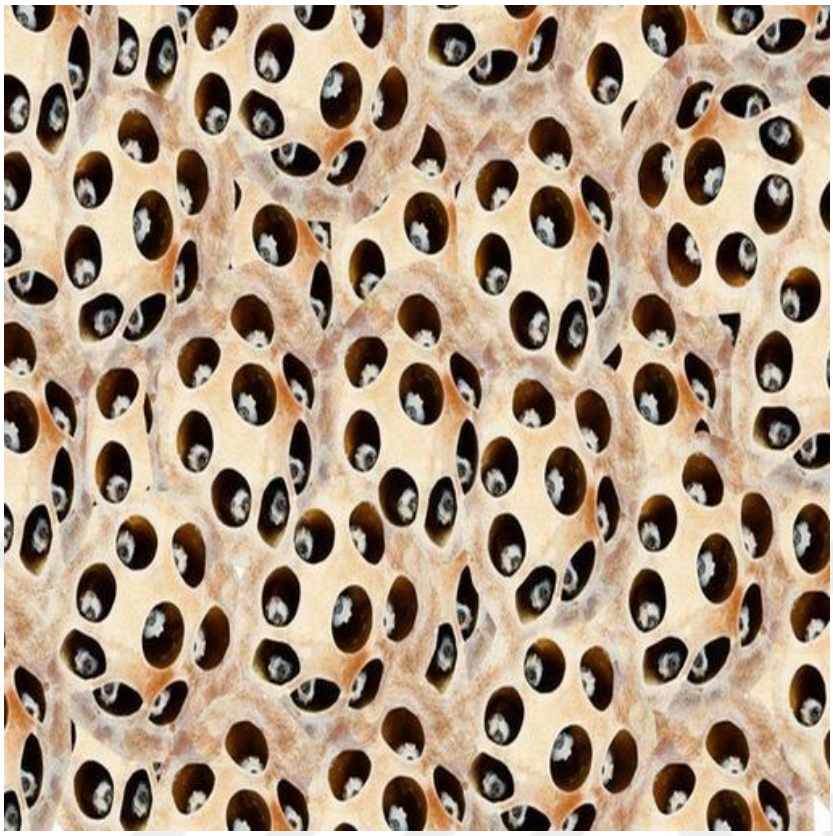
Appendix E – cvxEDA Code

```
GSRd = downsample(GSR,4);
GSRz = zscore(GSRd);
fss = 32;
nss = length(GSRz);
tss = (1:length(GSRz))'/fss;
[r, p, t, l, d, e, obj] = cvxEDA(GSRz, 1/fss);
SCLindex = mean(t)
```

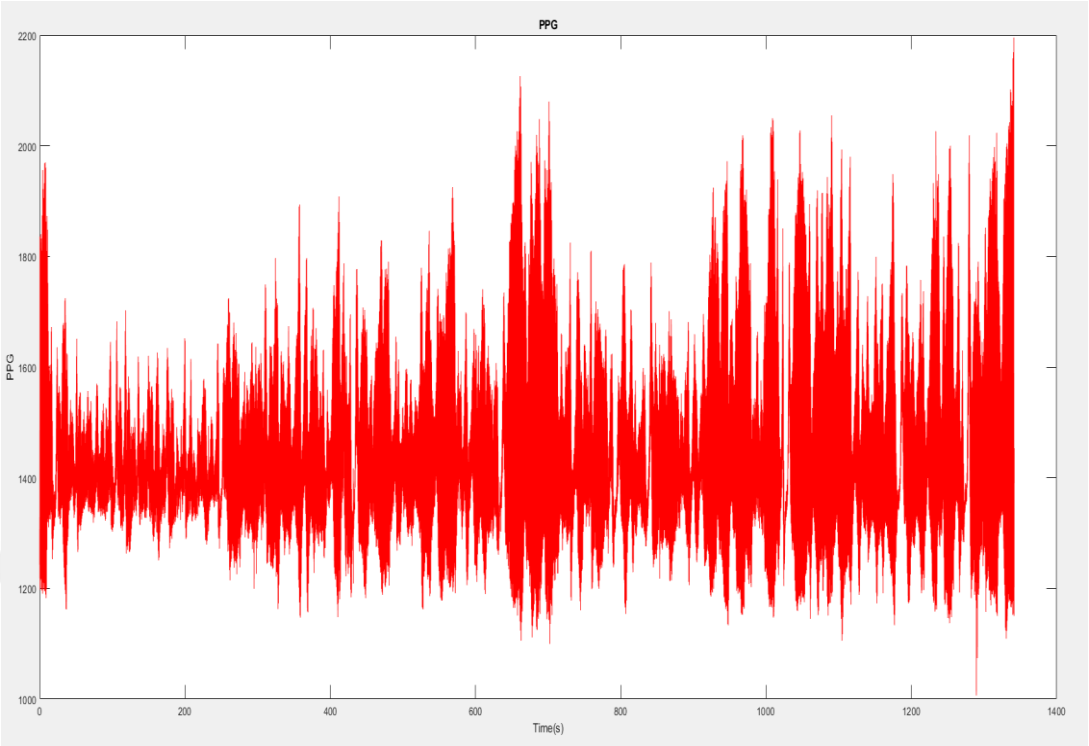
Appendix F – An Example of Skin-Relevant Stimulus Used in the Experiment



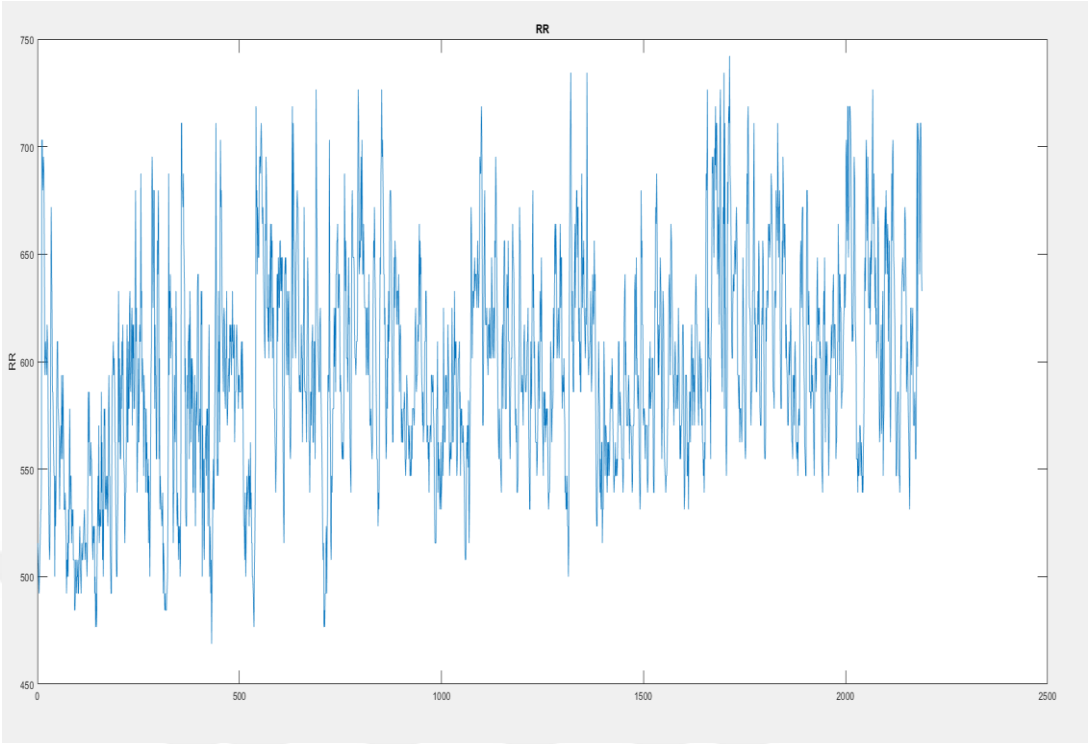
Appendix G – An Example of Non-Skin-Relevant Stimulus Used in the Experiment



Appendix H – An Example Graph of a Participant's Heart Rate



Appendix I – An Example of a Participant's R-R Tachogram



Appendix J – An Example Graph of a Participant's Skin Conductance Level (SCL)