A POSSIBLE LINK BETWEEN PERFECTIONISM AND NAVIGATIONAL STRATEGIES: IMPLICATIONS FOR LATE ADOLESCENCE

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL
OF
TED UNIVERSITY

BY

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
THE DEPARTMENT OF DEVELOPMENTAL FOCUSED CLINICAL CHILD AND ADOLESCENT PSYCHOLOGY

SEPTEMBER 2019

Approval of the Graduate School of TEDU

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ABSTRACT

A POSSIBLE LINK BETWEEN PERFECTIONISM AND NAVIGATIONAL STRATEGIES:
IMPLICATIONS FOR LATE ADOLESCENCE

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September 2019, 100 pages

The studies in this thesis aimed to investigate the possible link between perfectionism and navigational strategies in late adolescence from a developmental psychopathology perspective. Literature suggests that assessing navigational strategies is an efficient way to observe the involvement of multiple memory systems in the etiology of variety of psychopathologies. However, there has not been any study investigating perfectionism, which is a risky personality trait for developing psychopathologies, from this perspective. Accordingly, an experimental design involving a computer-based virtual maze paradigm was established to observe navigational strategies and the efficiency for the usage of these strategies. Forty-eight late adolescents and 32 young adults participated in the study. After the experiment, their perfectionism scores were assessed by using the Turkish adaptation of Frost Multidimensional Perfectionism Scale. The regression analyses indicated a possible link between participants' scores on some of the perfectionism subscales/dimensions and their navigational performances.

This link was largely group dependent with the navigational performance of different groups showing different sensitivities to perfectionism subscale scores. When Artificial Neural Networks (ANN) was trained according to these data, participants' maladaptive perfectionism scores could be predicted with great ease by behavioral data during training trials in the virtual maze. Related clinical implications, limitations and future directions for research were discussed.

Keywords: Late Adolescence, Perfectionism, Navigational Strategies, Multiple Memory Systems, Artificial Neural Networks

ÖZ

MÜKEMMELİYETÇİLİK VE YÖN BULMA STRATEJILERİ ARASINDAKI OLASI İLIŞKI: GEÇ ERGENLİK DÖNEMİNE DAİR ÇIKARIMLAR

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Eylül 2019, 100 sayfa

Bu tezdeki çalışmaların amacı; mükemmeliyetçilik ile yön bulma stratejileri arasındaki olası ilişkiyi gelişimsel psikopatoloji bakış açısı ile geç ergenlik dönemi için incelemektir. Çeşitli psikopatolojilerin gelişimde çoklu bellek sistemlerinin rolünü incelemek için yön bulma stratejilerilerinin gözlemlenmesinin etkili bir yöntem olduğu önceki çalışmalar tarafından desteklenmiştir. Fakat daha önce mükemmeliyetçiliği bu yöntem ile inceleyen bir çalışma bulunmamaktadır. Mükemmeliyetçilik, gelişimsel psikopatoloji açısından riskli kabul edilen bir kişilik özelliğidir. Bundan yola çıkarak yön bulma stratejilerini gözlemlemek ve bu stratejilerin ne kadar verimli kullanıldığını test etmek adına bilgisayar ortamında sanal bir labirent düzeneği oluşturulmuştur. Geç ergenlik döneminden 48 ve genç yetişkinlik döneminden 32 katılımcı deneye katılmıştır. Deney sonrasında katılımcıların mükemmeliyetçilik puanları Frost Çok Boyutlu Mükemmeliyetçilik Ölçeğinin Türkçe uyarlaması ile ölçülmüştür. Regresyon

analizleri bazı mükemmeliyetçilik alt ölçekleri ile yön bulma performansları arasında muhtemel bir ilişki ortaya koymuştur. Bu ilişki farklı cinsiyet ve gelişimsel basamaklar arasındaki etkileşimler için farklı dağılımlar göstermiştir. Bu sonuçlar göz önünde bulundurularak eğitilen Yapay Sinir Ağları (YSA) ile katılımcıların sanal labirentteki davranışlarından yola çıkarak uyumsuz mükemmeliyetçilik skorları tahmin edilebilmiştir. Bu sonuçların klinik alana olan katkısı, eksiklikleri ve ileriki çalışmalar için öneriler tartışılmıştır.

Anahtar Kelimeler: Geç Ergenlik Dönemi, Mükemmeliyetçilik, Yön Bulma Stratejileri, Çoklu Bellek Sistemleri, Yapay Sinir Ağları

To My Family

ACKNOWLEDGEMENTS

Through all the time, from the very beginning of the thesis until today, I felt the support of so many valuable persons that I would like to mention acknowledgements for. First of all, I would like to express my gratitude to my thesis advisor Assistant Prof. Çağrı Temuçin Ünal. Thank you for your friendly, caring and supportive attitude which gave me the power to go through this though process. I am grateful for the innovative ideas and rich knowledge you have provided which has broadened my horizons as a person and psychologist. I would like to thank Assistant Prof. Kutluk Bilge Arıkan for all the ideas and support for the research project. You and Çağrı hoca have believed in me more than I believe myself at the times that required steps out of my zones. I would like to thank Ethem Umut Kol, Bengü Akbal, Gizem Atak, Şükran Pehlivan and Melissa Tan for their interest in the project and helps in data collection. I would also like to thank Yağmur Ersan, Özge Beyza Albayrak and Ayşen Bağbaşı for their help in the data analyses.

I am very thankful to my family. Thank you for giving me all the support, love and encouragement. Your support has not been limited with our family bonds but reached to a technical level as well: I am lucky to have two engineers and one biologist at home.

I would like to thank all my dearest friends from the Master's Program, especially to Ece Urhan and Ceren Fırıncı; I cannot imagine how this process would be without you. To the members of ZEGA: Zeynep Kap, Esin Bulut and Gül Hunç Köse, thank you girls. I am so lucky to have them in my life since my childhood. I would like to thank Gözde Özdil for being with me whenever I needed. Thank you, my significant other Can Koçlar for just being you.

Finally, I would like to thank me for putting all the hard work, energy and patience into this process.

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CHAPTER 1

INTRODUCTION

Finding our way in the environment is one of our everyday tasks. Especially while navigating in a new environment, we can easily recognize that some people perform way better than others. What if we tell that our differences in navigational performance may give some clues about our tendencies for developing depressive thoughts, binge eating or obsessions? With the neuroscientific approaches today, we have a better understanding for the cognitive processes underlying daily psychological functioning. We now know better that a common neurobiology constitutes the foundations for different cognitive and emotional faculties. This provides us a chance to study some of the implicit processes that contribute to the etiology of psychopathologies (Wiers, Teachman, & De Houwer, 2007; Steinberg, Dahl, Keating, Kupfer, Masten, & Pine, 2015). The aim of the studies in this thesis combines the latter with the developmental clinical approach for a specific risk group, namely late adolescents.

Late adolescence refers to the period between adolescence and adulthood which can also be called *emerging adulthood*, and it refers mostly to 18-25 years of age. The claim of its existence in development is important for emphasizing that adolescence is not a period with a strict beginning and ending as it was thought before; it is a transitional one (Arnett, 2000; Zarrett & Eccles, 2006). This transition is affected by demographic, sociocultural, and labor market changes happening in the recent past. For instance; not all the 18 years olds involve to the labor market, go to military or get married as it was the case before the last 30

years (Zarrett & Eccles, 2006). Instead, most individuals aged between 18-25 years of age attend college and still stay at their parents' house and are not involved in the labor market and they are likely to get married in their mid or late 20s. Therefore, the time until having full adult roles seems to get delayed (Arnett, 2000). Compared with adults, this life period includes more of an unstable life structure and "in-between" feeling (Sussman & Arnett, 2014; Auerbach, Mortier, Bruffaerts, Alonso… & Murray et al., 2018). In addition, emerging adults are required to make important decisions about their careers, relationships and forming an adult identity in a world with increased possibilities and challenges for them. Therefore, late adolescence can be an over stressful period for most of the individuals (Zarrett & Eccles, 2006), which contribute to the risk factor for developing a number of psychopathologies. The epidemiological studies show that the emergence of most of the psychopathologies which have high adulthood prevalence rates such as eating disorders, mood disorders, anxiety disorders, panic disorder, depression, obsession-compulsion disorder corresponds to late adolescence period (Lensi, Cassano, Correddu, Ravagli, Kunovac & Akiskal, 1996; Tükel, Ertekin, Batmaz, Alyanak, Sözen, Aslantaş…& Özyıldırım, 2005; Ertan, 2008; Castello, Copeland & Angold, 2011; Steinberg et al., 2015; Auerbach et al., 2018). However, there is limited research focusing on this transitional period and its importance for the course of developmental aspects of psychopathology. (Schulenberg, Sameroff & Cicchetti, 2004). Specifically, this thesis aims to contribute to the elucidation of potential cognitive markers for the development of psychopathologies associated with perfectionism in late adolescence.

1.1 Perfectionism

Perfectionism refers to the desire of achieving perfection by putting high standards and self-criticism over not meeting those standards (Limburg, Watson, Hagger & Ergan, 2016). Even though this personality trait can provide some benefits like high motivation for success, it is acknowledged more by its maladaptive aspects (Schuler, 2000). With maladaptive perfectionism or "neurotic perfectionism", individuals describe unrealistically high and inflexible personal

standards, over-criticize themselves and feel constant dissatisfaction by their performance (Cox, Enns, & Clara, 2002). It creates a risk factor for the development of a number of psychopathologies (Shafran & Mansell, 2001; Egan, Wade & Shafran, 2011). Considering the transitional importance and risky features of late adolescence, investigating perfectionism in this period may provide a better understanding for the etiology of the abovementioned psychiatric disorders and developing successful treatment and even prevention strategies.

Since its first introduction in the literature, perfectionism has been very controversial on its theoretical models and assessment procedures. The following part provides a summary of this debate. In the last section, the evidence about the link between perfectionism and psychopathologies are presented.

1.1.2 Multiple Dimensions Theory of Perfectionism

At the beginning, perfectionism was explained as one factor model (Burns, 1980). However, the following studies in literature revealed a multi-dimensional structure (Frost, Marten, Lahart & Rosenblate, 1990; Hewitt & Flett, 1991; Sayıl, Kındap, Bayar, Bayraktar, Kurt, Tıgrak, Yaban, 2012). The most famous and accepted theories about multi-dimensionality were introduced by Hewitt & Flett (1991) and Frost et al. (1990).

Hewitt & Flett (1991) highlights perfectionism more with its relational aspect and proposes perfectionism in 3 dimensions; self-oriented perfectionism, other- oriented perfectionism and socially prescribed perfectionism. *Self- oriented perfectionism* refers to one's high expectations for her/his personal standards. Therefore, it leads to constant evaluation of one's own behaviors. *Other-oriented perfectionism* includes high expectations from people in close relationship and evaluation of their behaviors accordingly. *Socially prescribed perfectionism* defines one's desire to be perfect in other people's eyes. It includes a strong belief that others will give value/love to the individual if only he/she acts perfectly. These three dimensions are included in the Hewitt-Flett Multiple Perfectionism Scale (HFMPS) (Hewitt & Flett, 1991). On the other hand, Frost et al. (1990)

propose a 6 dimensional model in Frost Multiple Perfectionism Scale (FMPS); *Concern over Mistakes* assesses degree of reaction to one's own mistakes, tendency to attribute these mistakes as failure and belief that others' respect will change based on the failure. *Doubts about Actions* dimension refers to unsatisfied feeling through actions and desire for checking behaviors. *Personal Standards* dimension is based on the idea that perfectionist individuals set their personal standards very high and self-evaluate themselves based on these standards. *Parental Expectations* dimension suggests that perfectionists grow up in a family environment where love and acceptance are conditional. To receive love and acceptance, children have to perform everything perfectly. Another dimension relating to that theory is *Parental Criticism.* It is believed that parents with high expectations over-criticize their children's mistakes. Finally, *Organization* dimension refers to possible preference of perfectionists for ordered and structured tasks in order to ensure perfection.

Both of FMPS and HFMPS are the most widely used perfectionism scales in the literature. Even though these two models were developed independently, they share some common aspects. However, there are limited studies investigating the similarities between them (Cox, Enns & Clara, 2002). Frost, Heimberg, Mattia, Neubauer (1993) compared the two models and showed that that there is a correlation between Frost's *Personal Standards* sub-scale and Hewitt & Flett's *Self-Oriented Perfectionism*. In addition, Frost's *Parental Expectations*, *Parental Criticism* and *Concern over Mistakes* sub-scales are correlated with Hewitt & Flett's *Socially Prescribed Perfectionism*. The authors indicated a two-factor model from the analyses of total nine subscales as "maladaptive evaluation concerns" and "positive achievement striving". According to that, *Concern over Mistakes*, *Doubts about Actions*, and *Parental Criticism* and *Socially Prescribed Perfectionism* were associated with the negative aspects of perfectionism or "maladaptive evaluation concerns". On the other hand, *Personal Standards* and *Organization* subscales were related with positive aspect of perfectionism or "positive achievement strivings". This claim led to a further debate about whether

perfectionism can be considered in a two-dimensional structure; positive (adaptive) vs. negative (maladaptive) perfectionism.

1.1.3 Adaptive-Maladaptive Perfectionism

Cox, Enns & Clara (2002) investigated whether FMPS and HFMPS items can be a viewed in a two-dimensional structure by considering the suggestions of Frost and colleagues (Frost et al., 1993). 412 outpatient adults, 288 first-year healthy university students and 96 healthy medical students participated in their study. Their results confirmed the previous research and showed that *Concern over Mistakes*, *Doubts about Actions* and *Parental Criticism* and *Socially Prescribed Perfectionism* can be considered as "maladaptive perfectionism". For "adaptive perfectionism"; *Organization* subscale, *Personal Standards* subscales are fitted. *Other Oriented Perfectionism* subscale from HFMPS and *Parental Expectations* subscale from the FMPS were not related with maladaptive-adaptive model. The following studies suggested similar models such as "active vs. passive perfectionism" (Adkins & Parker, 1996)," functional and dysfunctional perfectionism" (Rhéaume, Freeston, Ladouceur, Bouchard, Gallat, Talbot, 2000), "conscientious and self-evaluative perfectionism" (Hill, Huelsman, Furr, Kibler, Vicente, Kennedy, 2004), and "2x2 model of dispositional perfectionism" (Gaudreau & Thompson, 2010). The common feature of all these models is categorizing perfectionism either as positive or negative (Stoeber & Otto, 2006). The reason for this tendency is to highlight the fact that perfectionism is related to the development of psychopathologies; to assess this link better and develop treatment models accordingly. It is also important to consider that perfectionism may not always be a negative trait (Stoeber & Otto, 2006; Zhang, Gan & Cham, 2007).

The common feature of maladaptive and adaptive perfectionism dimension is that both of them emphasize high personal standards. The difference is that while adaptive perfectionists can evaluate these standards in a flexible way with a positive self-concept, maladaptive perfectionists set unrealistically high and

inflexible personal standards, over-criticize themselves and feel constant dissatisfaction by their performance with excessive fear of failure (Soenens, Vansteenkiste, Luyten, Duriez, Goossens, 2005; Cox, Enns & Clara,2002; Sayıl et al., 2012).

1.1.4 Perfectionism and Psychopathologies

As mentioned before, development of many psychopathologies such as obsessive compulsive disorder (OCD), mood disorders, anxiety and eating disorders are associated with maladaptive perfectionism (Huggins, Davis, Rooney, & Kane, 2008; Shafran & Mansell, 2001; Egan, Wade & Shafran, 2011; Limburg, et al., 2016). This section provides some theoretical models and evidences for this link and emphasizes its importance for late adolescence period.

1.1.2.1 Psychological Distress and Perfectionism

Stress is a natural and necessary response of the body in order to function in an adaptive way. However, when the stress level gets excessive and cannot be regulated for a long period of time, it turns into a maladaptive form, named "distress". Experiencing distress makes individuals feel overwhelmed and trapped by the surrounding acute or chronic stressors. In addition, it creates dysfunctions in healthy coping mechanisms and weakens the immune system of the body, which in turn can harm physical and mental well-being (Ensel & Lin, 1991; Butcher, Mineka & Hooley, 2017).

Perfectionism is considered as a risk factor for psychological distress. Especially the role of cognitions related to perfectionism traits are highlighted (for a review; Macedo, Marques & Pereria, 2014). According to that, "dysfunctional" thoughts or "perfectionism thoughts" (Shafran & Mansell, 2001) account for variance in distress since they can create a constant inadequacy feeling while evaluating others and/or self (James, Verplanken & Rimes, 2015). This idea was acknowledged while developing the Perfectionism Cognitions Inventory (PCI) by Flett, Hewitt, Blankstein & Gray (1998). The role of perfectionism in psychological distress is especially important in understanding the risk factors for

psychopathologies. For instance; perfectionist individuals who are fearful of making mistakes and being evaluated negatively by others can feel hopeless and worry a lot about their future which can make them vulnerable for developing depression (Shaftan & Mansell, 2001). Depression is one of the psychiatric disorders which is mainly characterized by sad mood, sleep problems, low energy, feeling hopeless and helpless, having low self-esteem, decline in efficiency of cognitive processes and psycho-motor abilities Severe form of this disorder may also lead to suicidal ideation (American Psychiatric Association, 2013). Literature suggests that there is a strong link between perfectionism, psychological distress and suicidal ideation (Limburg et al., 2016). Another important finding is that maladaptive perfectionists who constantly ruminate, which refers to over and constant thinking on a single topic, seems to have higher risk for psychological distress and depression (Bardone-Cone, Wonderlich, Frost, Bulik Mitchell, Uppala & Simonichet al., 2007; Di Schiena, Luminet, Philippot & Douilliez, 2012; Short & Mazmanian, 2013).

The studies looking at perfectionism in two dimensions (maladaptive vs. adaptive perfectionism) highlights the link between perfectionism, psychological distress and related symptoms in late adolescence. Zhang, Gan & Cham (2007) investigated whether two dimensional analysis of perfectionism can explain the academic burnout vs. academic engagement in Chinese college students. The results confirmed the link between maladaptive perfectionism (concerns over mistakes, doubts about actions and parental expectations) with academic burnout, as well as adaptive perfectionism (high personal standards and organization) with academic engagement. Similar results were obtained in Western cultures (Zhang et al.2007; Schaufeli & Bakker, 2004; Schaufeli, Martinez, Marques-Pinto et al., 2002). Another study with medical students sample showed that maladaptive perfectionism is linked with higher levels of "acceptable" school performance, distress, depression and suicidal ideation after participants' gender, age and school grades were controlled for (Enns, Cox, Sareen & Freeman, 2001). In addition, the facilitator effect of rumination between perfectionism and psychological distress

was evidenced by Flett, Hewitt & Heisel (2002) for a college student sample. Therefore, maladaptive perfectionism seems to contribute to psychological distress and related symptomatology in late adolescence.

1.1.2.2 Eating Disorders and Perfectionism.

Eating Disorders, which are under the heading Feeding and Eating Disorders according to latest manual of Diagnostic and Statistical Manual of Mental Disorders (DSM-5), are characterized by disturbances in eating behavior which leads to impairments in physical and psychological well-being. This category includes pica, rumination disorder, avoidant/restrictive food intake disorder, anorexia nervosa, bulimia nervosa and binge-eating disorder (American Psychiatric Association, 2013). To date, the research about perfectionism and eating disorders have mostly focused on its relation to anorexia nervosa (AN) and bulimia nervosa (BN) (Bardone-Cone et al., 2007).

AN is characterized by having a) significantly low body weight b) excessive fear to gain weight or of becoming fat c) disturbed evaluation on one's own weight and body image (i.e. perceiving one's own body as fat even when the individual is underweight). On the other hand, in BN; the patient shows a) binge-eating behavior (excessive and uncontrollable eating for a short period time) b) maladaptive techniques to prevent weight-gain such as self-induced vomiting and excessive exercising c) over occupation about self-image and body weight (American Psychiatric Association, 2013). For both of the disorders, the common desire to have perfect body image or weight can be considered as "perfectionistic in its nature" (Egan, Wade & Shafran, 2011). In line with this thinking, perfectionism is considered as a predisposing personality trait for the occurrence of AN and BN. In other words, someone who has perfectionist traits has more risk for developing an eating disorder. Not surprisingly, individuals with eating disorders have higher levels of perfectionism scores compared to healthy controls. Especially, among the sub-scales of perfectionism, the scores of *Concern over Mistakes* and *Personal Standards* were significantly higher (Bardone-Cone et al.,

2007; Egan, Wade & Shafran, 2011). Interestingly, while personal standards sub-type is normally considered as a part of adaptive perfectionism, it seems to display maladaptive characteristics in the etiology of eating disorders (Stoeber & Otto, 2006; Bardone-Cone et al., 2007; Sassaroli, Lauro, Ruggiero, Mauri, Vinai, & Frost, 2008).

Literature highlights perfectionism as a risk factor especially for female late adolescents in developing eating disorders. Steele (2007) evidenced that higher personal standard scores lead to bulimic symptoms in undergraduate women over a 3 months period. Downey & Chang (2007) highlights "negative affect" as a mediator on this relationship. On maladaptive/adaptive dimensions manner, both *Personal Standards* from FMPS and *Self-Oriented Perfectionism* from HFMPS were positively correlated with anorexia and bulimic symptoms (Chang et al., 2008). Therefore; the maladaptive/adaptive dimensional model may not be suitable for assessing the risk for eating disorders in late adolescence sample too.

1.1.2.1 Obsessive Compulsive Disorder and Perfectionism

Research suggests an intimate relationship between perfectionism and obsessive-compulsive disorder (OCD) (Frost, Marten, Lahart & Rosenblate, 1990; Shafran & Mansell, 2001; Egan, Wade, & Shafran, 2011; Limburg et al., 2016). OCD is a psychiatric disorder that is characterized by having a) disturbing, uncontrollable and resistant thoughts called "obsessions" and/or b) behaviors called "compulsions" that are performed as response to obsessions. Examples for the common compulsions are washing hands, organizing items, checking things, counting and repeating words (Markarian, Larson, Aldea, Baldwin, Good, Berkelijon, Murphy, Storch & McKay, 2010; American Psychiatric Association, 2013).

Studies showed that OCD patients have an instinct drive for perfection and certainty (Markarian et al., 2010). In response to their obsessions, they try to perform their compulsions in a perfect way. Until they feel having achieved

perfection, they may experience what is called as "not just right experience" (Ghisi, Chiri, Marchetti, Sanavio, & Sica, 2010; Coles, Frost, Heimberg, & Rhéaume, 2003). Not just right experience refers to constant feeling of imperfection that creates excessive doubts about the performed behavior. This phenomenon is considered as a common pattern with maladaptive perfectionism, acknowledged by "Doubts about Actions" subscale of Frost's Multidimensional Perfectionism Scale (FMPS) (Frost et al., 1990; Shafran & Mansell, 2001). Also, among subscales of FMPS, "Doubts about Actions" and "Concern over Mistakes" are the ones that relate to OCD symptomatology the most (Shafran & Mansell, 2001; Sassaroli et al., 2008; Limburg et al., 2016). In addition, some researchers describe perfectionism as one of the six key cognitive factors of OCD, which have been followed by the inclusion of "Perfectionism" subscale into Obsessive- Beliefs Questionnaire (OCCWG, 1997; OBQ; 2001). Therefore, it can be said that perfectionism and OCD share some etiological similarities as well as domains for their measurements.

Studies with late adolescence sample also confirm the above mentioned similarities between perfectionism and OCD. However, there are some contradictory results about which dimensions of perfectionism are more associated with OCD symptomatology. Rice & Pence (2006) evidenced that the interaction of high perfectionistic discrepancy and self-standards predicts obsessive thoughts and compulsions in non-clinical late adolescence sample. This result indicates that high personal standards might be maladaptive for the etiology of OCD, which is consistent with eating disorders etiology (see above; Rice & Pence, 2006; Stoeber & Otto, 2006; Bardone-Cone et al., 2007; Sassaroli et al., 2008). On the other hand, Suzuki (2005) claims that regardless of having high standards, people who have high levels of concern over mistakes tend to have OCD symptoms. Another important finding is that intolerance of uncertainty (IU) mediates the relationship between perfectionism and severity of OCD symptoms in late adolescence (Reuther, Davis, Rudy, Jenkins, Whiting & May, 2013).

The common denominator of all the psychopathologies mentioned above involves an inflexibility of behaviors and their underlying cognitive processes (Shafran, Egan & Wade, 2018). In line with this thinking, cognitive strategies might be indicative of impending psychopathologies (Goodman, Marsh, Peterson & Packard, 2014). Multiple memory systems are one of the explanatory models in the developmental psychopathology field (Goodman et al., 2014). The following part explains multiple memory systems and the possible ways to investigate perfectionism from this perspective.

1.2 Multiple Memory Systems

Multiple Memory Systems theory claims that memory is composed of multiple systems that rely on different neuroanatomical structures and operating principles (Gasbarri, Pompili, Packard & Tomaz, 2014). Particular curiosity on the presence of multiple memory systems stem from the studies of Scoville and Milner (1957) on patient Henry Molaison, known to the scientific community as H.M. He was suffering from severe epileptic seizures which is a brain disorder characterized by unpredictable and periodic firing of large group of neurons that result in physically and socially devastating symptoms such as unpredictable episodes of vigorous shaking (Purves, Augustine, Fitzpatrick, Katz, LaMantia, McNamara, & Williams, 2001). At the age of 27, he has undergone a surgery where part of his hippocampus and other surrounding areas that were thought to create the seizures was removed. Careful investigation on his case revealed interesting aspects regarding his memory function. While he suffered from severe anterograde amnesia (the inability to recall information that is received after the surgery), he was still able to perform as well as healthy individuals in tasks that assess implicit memory function (Scoville & Milner, 1957; Poldrack & Packard, 2003; Smith & Kosslyn, 2013). These findings along with Edward Tolman's seminal findings in his animal work (1948) reinforced the notion that memory is composed of different systems, each potentially mediated by different brain regions. Converging evidence from human and animal studies indicate a *double dissociation* in memory function (i.e. Packard & McGaugh, 1992; Gabrieli,

Fleischman, Keane, Reminger & Morrell, 1995; Aggleton, Neave, Nagle & Sahgal, 1995; Glisky, Polster & Routhieanx, 1995; Winocur, Moscovitch & Stuss, 1996; Packard & Teather, 1997) Double dissociation refers to two different brain areas being responsible for separate cognitive process serving either different or similar purposes (Davies, 2010). According to that, the hippocampus mediated system underlies the declarative memory system which supports the learning of relationship among items and events. It is largely studied using navigational learning and object recognition in animals as these types of recollections show phenomenological similarities with episodic memories of humans (Bohil, Alicea, & Biocca, 2011; Gasbarri et al., 2014). Whereas the striatum, the principal input station of basal ganglia (the brain area that is primarily responsible for modulation of movement) controls the formation of skill or habit memories (Gasbarri et al., 2014).

1.2.1 Multiple Memory Systems and Development of Psychopathologies

It is claimed that human psychopathologies can be explained within the learning framework, where processing of events by different subsystems is also thought to influence emotional processes (Goodman et al., 2014). In order to understand this relationship, this section first discusses the relationship between stress and habit learning, and then explains this link in terms of psychopathologies consisting of habit-like behaviors.

Several animal and human studies indicate that stress and drug-induced anxiety lead to behaviors primarily controlled by the habit (i.e. stimulus-response) systems of the brain (for a review; Gasbarri et al., 2014). These effects are mediated by neurotransmitters and hormones like glucocorticoid that exhibit an augmented released after stressful experiences (Packard, 2009; Schwabe, 2013; Gasbarri et al., 2014). In human studies, both acute and chronic stress promotes the use of habit strategies (Steidl, Mohi-uddin & Anderson, 2006; Stedl, Razik & Anderson, 2011; Gasbarri et al., 2014). Considering perfectionism as a contributor to stress level (explained above), a similar learning pattern might be hypothesized

for perfectionist individuals. Another overlooked aspect concerns how stress impacts the efficacy of these systems.

Experiments with humans and rats have shown that distinction between hippocampus-dependent and striatal dependent learning can provide unique insights about the development of distinct psychopathologies. Specifically, abnormalities in the hippocampus might augment the work-load of striatum as occurs in like Tourette syndrome, obsessive compulsive disorder (OCD), eating disorders and autism spectrum disorder (Marsh, Alexander, Packard, Zhu, Wingard, Qackenbush & Peterson, 2004; Goodman et al., 2014). For instance, eating disorders are characterized by a disturbance when patients do not perform the maladaptive learned behaviors such as excessive exercise and binge eating for BN (Gasbarri et al., 2014). A similar pattern is also observed for OCD patients. Repetitive behaviors in clinical picture of OCD suggests an over active striatum, possibly compensating for distorted hippocampal activity (Markarian et al., 2010; Wee, 2005; Goodman et al., 2014). Considering perfectionism as a leading factor of OCD and eating disorders, a similar involvement might shape the relationship between learning and perfectionism. To my knowledge, this possible link has not been studied yet.

1.2.2 Navigational Strategies

One of the methods for studying the involvement of hippocampal learning vs. dorsal striatal learning is observing navigational strategies (Shmitzer-Torbert, 2007; Stuchlik, Kubik, Vlcek,& Vales, 2014). The neuroimaging evidence in virtual maze experiments showed that both hippocampus and striatum mediated memory systems have complementary and sometimes competitive roles in navigational behavior (Iaria, Petrides, Dagher, Pike, & Bohbot, 2003; Goodman et al., 2014; Zhong & Moffat; 2018). In the following section, the rationale for using navigational tests is explained. In addition, the importance of developmental stages while observing navigational abilities are highlighted.

1.2.2.1 Cognitive Representations and Navigational Learning.

Navigational learning requires human mind to store relative information about the location of target objects (Ruggiero, Errico & Ianchini, 2016). Before the storage, the information is first needed to be perceived and accumulated. After perception occurs through different sensory channels (i.e. proprioceptive, vestibular, auditory, visual and tactile), mental representations involving different sensory modalities are formed. Mental representation refers to mental coding of the information about the objects, people, environment and experiences to form an understanding about our outside and inside world (Brained & Reyna, 2002; Case 1992; Piaget, 1983; Bjorklund & Myers, 2015). These representations are fundamental for the cognitive development and processes. For instance; for a baby to develop *object permanence*, which is the ability of being conscious that an object/a person still holds a place in space even though it is not in baby's current visual field, there needs to be a mental representation of the object in baby's mind. This is the only way that the object can hold a place in memory and this representation can be utilized for thinking, learning new relations and remembering (Piaget, 1952; Bjorklund & Myers, 2015). Apart from beacon learning where stimuli in the immediate vicinity of the target object and/or stimuli that have a very explicit spatial relationship to the target object are coded for (a process that resembles sign tracking observed in classical conditioning experiments), there are two distinct ways spatial information can be represented; egocentric and allocentric representation (Ruggiero, Errico & Ianchino, 2016; Hu, Yang, Huang & Shao, 2018).

Egocentric representation or object-to-self relation refers to coding the object's position according to one's own body, such as "the bed is on my right". Use of this representation is referred as a response strategy, getting its name from stimulus-response (S-R) learning. This type of representation is mediated by the dorsal striatum. Placidly, this strategy corresponds to finding a target by using of a fixed sequence of actions by taking one's own position as reference. Therefore, it

is navigating through a first-person's eye view (e.g. "I should make right, right and then left to reach the bed ") (Zhong & Moffat, 2018).

Allocentric representation or object-to-object representation refers to the coding of the object's position with respect to its external environment (e.g. "the bed is next to the table"). This navigational strategy that is based on an allocentric representation is called "place strategy". This strategy is supported by the hippocampus, and it is associated with cognitive mapping (Tolman, 1948; O'Keefe & Nadel, 1978) Cognitive mapping refers to having a spatial representation in cognition similar to a map from a bird's eye perspective (Wolbers & Hegarty, 2010). Therefore; the participant can locate the target object in this map and navigate his/her way flexibly. (Hu, Yang, Huang & Shao, 2018; Wolbers & Hegarty, 2010).

1.2.2.2 Development of Cognitive Representations and Navigational Learning.

Literature shows a developmental trajectory for the maturation of navigational strategies parallel with the development of representations for the world. In a developmental sense, an infants' ability to form egocentric representations can be observed around 9 months of age and usage of allocentric representations emerge around his/her second year of age (Landau & Spelke, 1988, Hermer & Spelke, 1994). However, the ability to use allocentric representations is not stable until 4 or 5 years of age. Therefore, egocentric representations seem to mature earlier in development than allocentric representations (Newcombe & Huttenlocher, 2003; Hu et al., 2018), a pattern paralleled by the earlier maturation of the striatum as compared to the hippocampus in mammals (Goodman et al., 2014). In experiments where children need to perform in maze tasks with using hippocampal-dependent learning, 6-12 years olds showed fewer errors than 2-5 years of age children (Overman, Pate, Moore & Peuster, 1996; Goodman et al., 2014). Some studies evidenced that there might be a gradual shift from striatum dependent strategies to hippocampal-dependent strategies between 5 and 10 years of age (Iglo´i, Zaoui, Berthoz, &

Rondi-Reig, 2009). Interestingly, this shift is parallel with the shift from preoperations stage (2 to 7 years) to concrete operations stage (7 to 11 years) in cognitive development, a shift link with a reduction in egocentric thinking (Bjorklund & Myers, 2015). This shift is thought to allow children to develop their perspective taking which is crucial for their social skills (Choudhury, Blakemore & Charman, 2006).

During adolescence years, the brain undergoes considerable developmental changes in almost every structure, especially in the cortex, the frontal lobes and parietal lobes (Whitford, Rennie, Grieve, Clark, Gordon & Williams, 2007; Levesque, 2011). After the peak of the gray matter (GM) volume (density of cell bodies and neuropil in the brain and spinal cord) in the parietal lobe and frontal lobes during 11-12 years, the GM volume in these areas starts to decline. This decrease is followed by an increase in white matter (WM) (light appeared tissue of myelin) density in frontal lobe and hippocampus which is associated with an improvement in higher cognitive processes and usage of memory (Choudhury, Blakemore & Charman, 2006; Levesque, 2011). During the late teens (16-18 years of age) and the 20s, there is a shift toward acquiring knowledge via experience and a decrease in knowledge acquisition via rote processing (e.g., memorization). This shift is parallel with developmental tasks on late adolescence years that require success on real-life experiences such as trainings about professions, house-hold works, forming long-lasting relationships and so on (Tanner, 2011).

There is a decline in navigational performance after early adulthood years, possibly due to a decrease in gray matter and other aging factors. (Colombo, Serino, Tuena, Pedroli, Dakanalis, Cipresso & Riva, 2017). Rodgers, Sindone & Moffat, 2012) investigated the effect of aging on navigational strategies. The results showed that older adults (aged 55 to 85) were more likely to adopt an egocentric strategy (only 7 of the 40 older adults preferred an allocentric to egocentric strategies) while younger adults (aged 18-35) were likely to adopt both strategies almost equally. Iaria et al. (2003) also found a similar result that young adults (mean age 27, 7) adopted both strategy almost equally in a virtual maze

paradigm. Even though the frequency for the usage of type of navigational strategy differs along the ages, performance in using egocentric representations results more accurate in all age groups. In a recent comprehensive study, 283 healthy participants aged 6 to 89 years were tested on same spatial memory task that includes both allocentric and egocentric trials (Ruggiero, Errico & Ianchini, 2016). The results showed that in all age groups, usage of egocentric representations were more accurate and faster compared to allocentric representations. This is also supported by the study of Hu, Yang & Shao (2018). Considering the performance for both of the representations, children aged 6-7 years and elderly group aged 80-89 years were the slower and least accurate age groups. This effect was still significant after age-related decline in pure visual and visuo-spatial (i.e. size of the target objects) features were controlled for. Between 10 to 60 years, the level of accuracy appeared homogeneous for both allocentric and egocentric representations. In summary, while a tendency towards using egocentric strategies in children can be linked to the earlier maturation of striatum, the tendency towards using egocentric strategies in the older age group might be linked to the effects of the aging factors impacting the medial temporal lobe structures. What is interesting is that the egocentric performance shows a peak in accuracy during late adolescence (Ruggiero, Errico & Iachini, 2016).

1.2.2.3 Sex Differences and Navigational Strategies.

Literature emphasizes sex difference as an important variable in explaining variances for usage of navigational strategies. Even though there are mixed findings (Coluccia & Louse, 2004), most of the studies indicate that men uses place strategies more efficiently compared to women. According to that, women tend to navigate according to environmental and landmark features that are directly available on their visual field (i.e; "you must turn right near the bed"). On the other hand, men tend to use environmental geometry and metric distances in conditions where all the environmental information is available (i.e; you must turn right after 200 metres) (Galea & Kimura, 1993; Lawton, Charleston & Zieles,

1996; Lawton, 1994; O' Laughlin & Brubaker, 1998; Chai & Jacobs, 2009; for a review, see Coluccia & Louse, 2004; Wolbers & Hegarty, 2010).

The sex hormones are considered as the main causal factor for the gender differences observed in navigational strategies in animals as well as humans (Korol, Malin, Borden, Busby & Couper-Leo, 2004; Chabanne, Peruch & Thinus-Blanc, 2004; Bell & Saucier, 2004; Burkitt, Widman & Saucier, 2007; Driscoll, Hamilton, Yeo, Brooks & Sutherland, 2005; for a review, see Wolbers & Hegarty, 2010). In humans, women are found to perform better in the beginning of their menstrual cycle (when the concentration of estrogen level is low) while men perform better when their concentration of testosterone level is higher during the day (Moffat & Hampson, 1996).

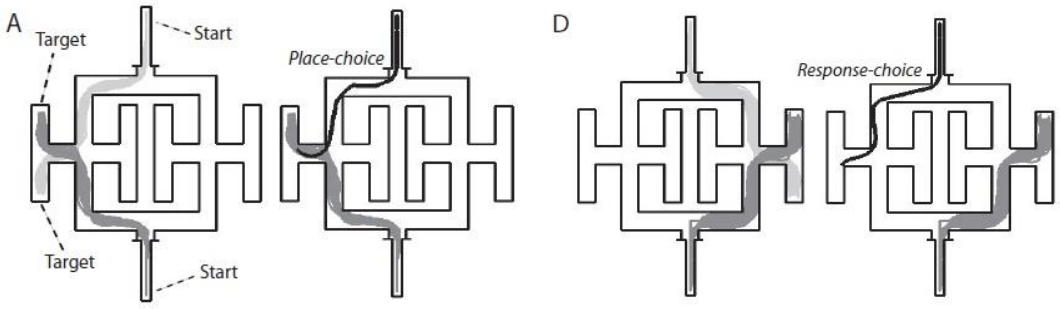
The correlational studies also reveal some factors in explaining sex differences in navigational strategies. First of all, "spatial anxiety" (Lawton, 1994; Lawton, Charleston & Zieles, 1996) or "fear to get lost" (Kozloswki & Bryant,1997) seems higher in women (Coluccia & Louse, 2004; Saucier & Green, 2002; Schmitz, 1997) a factor thought to impairs the spatial memory performance (Mackingtosh, West & Saegert, 1975; Evans, Skorpanich, Garling, Bryant, & Bresolin, 1984; Sunanda, Rao & Raju, 2000; for a review, see Coluccia & Louse, 2004) and is negatively associated with the use of place strategies (Lawton, 1994). Secondly, navigational experiences (the degree of exposure to maps, playing video games, driving… etc.) can change the performance on navigational tasks (Wolbers & Hegarty, 2010). In terms of gaining experience; men are more advantageous than women as a result of gender roles and social opportunities provided (Barnett, Vitaglione, Harper, Qualenbush, Steadman & Valdez, 1997). However, it is claimed that the differences on previous experience only have an effect on the performance in time-dependent tasks but not in the memory retrieval cognitive tasks (i.e. path length measures of navigation performance) (Akinlofa, Holt & Elyan, 2014).

In order to investigate the effects of the above mentioned variables, Castelli, Corazzini & Geminia (2008) tested 40 healthy young adults (20 male; *M*= 24.5, *SD*= 2.2. and 20 female; *M*= 24.5, *SD*= 2.7) on their navigational abilities in virtual maze paradigm. The participants also filled out self-report scales about their experience playing computer games, spatial anxiety, way-finding strategies and sense of direction. Results showed that in route learning tests in which the participants need to use more of response learning, there were no significant gender differences in time and trials needed to complete. However, in survey knowledge test in which participants need to use more of place learning, men performed significantly better than women. Men also performed better in a new environment paradigm when both sexes were provided with equal sufficient experience with a training phase. Interestingly, this effect was still significant after controlling for video games experience and spatial anxiety, consistent with previous findings (Moffat, Hampson & Hatzipantelis, 1998; Coluccia & Louse, 2004; Saucier & Green, 2002; Schmitz, 1997).

1.3 Perfectionism, Navigational Strategies and Late Adolescence

There is a scarcity of studies investigating navigational strategies in late adolescence. This is puzzling given the critical developmental processes that occur during those years (discussed above). In a recent experimental study of Schmitzer-Torbert (2007), healthy undergraduate students (32 females and 22 males) (*M*= 19.3, *SD*= 1.3) were tested for their navigational strategies in multiple virtual T mazes as shown in Figure 1. In this study, participants first practiced a symmetric maze in "training trials" and then went through "probe trials" where they started from opposite direction to find the target. During these probe trials, participants' strategies (place vs. response) were observed. Participants who went to the same location during probe trials (the trails in which they started from the opposite end of the maze) were classified as using "place strategy" and the ones who followed the same learned direction during these trials were classified as using "response strategy". The results supported the previous idea that the use of response strategy is reinforced as a result of increase in training trials (Shmitzer-Torbet, 2007;

Goodman et al., 2014). Another study of Etchamendy and Bohbot (2007) also shows a tendency towards this strategy change. They tested 30 healthy participants (*M*= 26.8, *SD*= 3.94) on a 4-on-8 virtual maze task and on a virtual town in order to observe participants' strategy choices according to task requirements. They found that 20 of the 30 participants solved 4-on-8 maze task by spatial strategy and 11 of these 20 participants shifted to a response strategy by end of the this task since due to the efficient nature of this strategy. The remaining 10 participants used a response strategy. The Study of Bohbot, Lerch, Thorndycraft, Iaria & Zijdenbos (2007) used neuroimaging procedures along with navigational data. The participants (*M*=27.9, *SD*=4.1.) who used place strategy showed higher activity in hippocampus with significantly more gray matter in hippocampus and less gray matter in striatum comparing with response strategy users. However, these studies did not consider the neuro-cognitive developmental stage as a determinant of navigational strategies, not to mention their relevance to psychopathologies.



.Figure 1. Multiple T Mazes and Navigational Strategies modified after Schmitzer-Torbert (2007). A: Path of the participants who used a place strategy on the probe trial. The left panel shows normal trials without errors while finding the target object. The right panel shows the behavior on the probe trial, shown in black. D: Path of the participants who used a response strategy on the probe trial. The left panel shows the normal trials without errors while finding the target object. The right panel shows the behavior on the probe trial, shown in black.

In order to observe the possible developmental differences in how memory strategy usage is related to perfectionism, the studies in this thesis investigates navigational strategies and perfectionism tendencies within and between late adolescents and early adults. Early adults are selected as a comparison group

because early adulthood is considered to be the point where multiple memory systems function independent from age related decline (Colombo et al., 2017; Rodgers et al., 2012). Therefore, the research questions are:

1) Is there a specific pattern of learning for Perfectionists? If so, can we observe it by navigational strategies?
2) Are there any interactions between perfectionism and developmental stage that are instrumental in determining the navigational strategies? How efficiently are these strategies utilized?
3) How does the sex of the participants influence the abovementioned aspects?
4) Is it possible to find behavioral markers for predicting perfectionism scores in different subscales?

The hypotheses based on the literature are:

1) a. Behaviors of adolescents will be more sensitive to perfectionism as the yet "immature" hippocampus will be less efficient in contributing to behavior.

   b. In both groups, the strategy choice will be almost equally distributed. However, the efficacy of usage of navigational strategies will be higher in late adolescence

2) a. The strategy choice will be predictable making use of behavioral data during training trials using neural networks.

   b. Adding group data (age group/ gender) along with select perfectionism scores (i.e. scores that predict path length during navigation) will increase the predictive power of artificial neural networks.

   c. It will be possible to predict perfectionism scores from behavioral measures recorded during virtual navigation.

3) Increased perfectionism will have a higher impact on the efficacy of path finding in individuals using response strategies in all age and gender groups.

CHAPTER 2

PİLOT STUDY

A pilot study was designed to test procedures and to make the necessary improvements for the main studies. The ethical permission for the research project was taken from TED University Human Subjects Ethics Committee (HREC) on 30.11.2018. The data collection for the pilot study was conducted between December 2018 and January 2019. The data collection for the main study was conducted between February 2019 and June 2019. For the project timeline, see Figure 3

The maze was created with Maze Maker software (Ayaz, Allen, Platek & Onaral, 2008), based on the multiple T maze paradigm of Schmitzer- Torbert (2007) which has dimensions of 96 units x 83.2 units. It includes 4 symmetrical arms and a main hallway having a width of 6.4 units. There are also two symmetrical starting arms of the maze; each has width of 3.2 units. The floor of the maze was grass and there was no ceiling with an open skybox view. Each arm of the maze were colored differently (light pink, medium green, dark red and dark purple) and the walls in the opposite sites of the main hallways were selected from the different tones of the same color; the walls on the first starting point direction were the tones of brown and the walls on the second starting point direction were the tones of gray. Finally, the color of the connection walls between the main hallway and each 4 arms were light yellow. To provide an additional cue, we added 4 doors. Two of them were located at the opposing wall of starting point 1. Other two doors were located cross wisely on the direction of starting position 2. See figure 2.

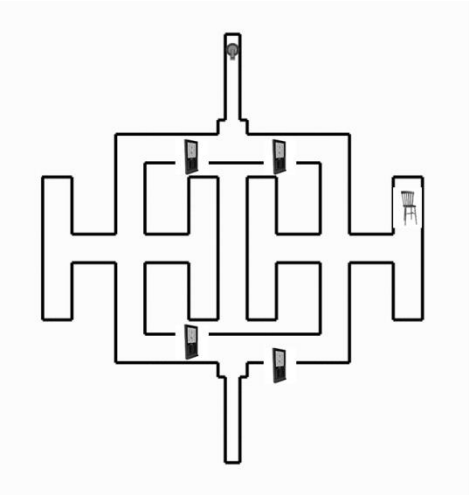


Figure 2. The representation of cues and the target object of the maze in experimental and probe trials of the pilot study. In the practice trial, the chair was not present.

2.1 Procedure

Verbal consent was taken from the voluntary participants. In total, 20 adults (11 females and 9 males) participated in the experiments. Subsequently, they sat in front of a computer in an available silent room. When they were ready, they clicked on the start button on the Maze Walker software (Ayaz et al., 2008). First, there was one practice trial in which participants were told to *get used to the control buttons while they are walking through the maze for 200 seconds*. After the allocated time passed, the practice trial automatically ended with written information on the screen. Once the participants clicked on the "OK" sign on the screen, the instructions of the experimental trial appeared as following: *In the experimental trials, you are required to find a chair located in the maze. You will be asked to find the chair for 10 times. You will earn +1 point each time you find the chair. You will be asked to find the chair one more time after acquiring 10 points. After that, the experiment will be finished.* (See Appendix A for the original Turkish instructions).

In *experimental* trials (finding the chair for 10 times) and the *probe* trials (finding the chair for the last time), the chair was always located in the same arm of the maze. Each time the participants found the chair, they were informed about

their points. Also a positive reinforcement was given in the form of "*Good Job*!", "*Perfect*!" and "*You made it*!" type of statements. In the *probe* trial, participants were started from the opposite starting location. If they walked the same path as in the experimental trial (e.g. left-right-left), the strategy was coded as "response" strategy. If they walked to the other direction and found the location of the chair, the strategy was coded as "place" strategy. I gave the information to participants verbally that *there is only one chair* located in the maze. However, when they asked if the chair is always at the same place or not, we told them *we cannot give this information*.

After the maze experiment, participants filled out a Turkish version of Frost Multidimensional Perfectionism Scale (F-MPS, 1990; Sayıl et al., 2012). The procedure took part between 20-30 minutes for each participant in total. After the experiment, we had a verbal discussion about their strategies and I listened to their feedbacks on the procedure.

2.2 Results and Discussion

Among 20 adults, only 5 participants showed a place strategy. Among 15 response learners, 5 of them reported verbally that they got suspicious about the possibility of *starting from the same location in the probe trial but the wall colors might have been changed on purpose.* Hence, they first used response strategy to ensure. When they realized that the chair is not at the same location, they started to attend external cues to find their way. Therefore, these participants changed their strategy from response strategy to place strategy. In order to increase their ability to differentiate between starting locations, I added additional cues as it is explained in the procedure section of *Main Study.*

Among five place learners, three of them reported that they realized the changing cues (doors, colors) and used this information in the probe trial while finding their way. Rest of the participants searched the chair in different maze arms during the experimental trials until they *got convinced that the chair is always at the same location*.

In the pilot study, the chair was located at the same corner maze arm for all participants. However, some of the participants (both place and response learners) reported that when they started to the experiment, they first wanted to check the corner maze arms and then look at the middle maze arms. Therefore, they easily found the chair. To eliminate the effect of this tendency on navigational learning process, I decided to locate the chair randomly on four different maze arms for each participant on the main study. Also, three of the participants experienced dizziness and sickness during the experiment. When we asked them the possible reason of this situation; they reported that firstly, *the colors of the maze walls are too vivid and bright*. Secondly, *the mouse is too sensitive to control the head movement*. Finally, *skybox view is too stable that makes every other movement in the environment seems like too much*. We evaluated these feedbacks and made some changes in wall texture, ceiling and the mouse control as it is explained in the procedure part of the *Main Study*.

The instructions for the experimental trials were not clear for most of the participants during the pilot study. They got surprised when the probe trial started by saying that "Oh, again? or "Oh, not ended yet?". We thought that the instruction *…You will be asked to find the chair for 10 times. For each time of finding, you will earn +1 point. Upon reaching 10 points, you will be asked to find the chair for the last time. After that, the experiment will be finished…;* the participants could think that the experiment was going to finish after reaching 10 points and the information about the existence of the last trial was forgotten. Considering the risk of losing participants' motivation for the probe trial, we decided to change this instruction. The new version is explained in the procedure section of Main Study.

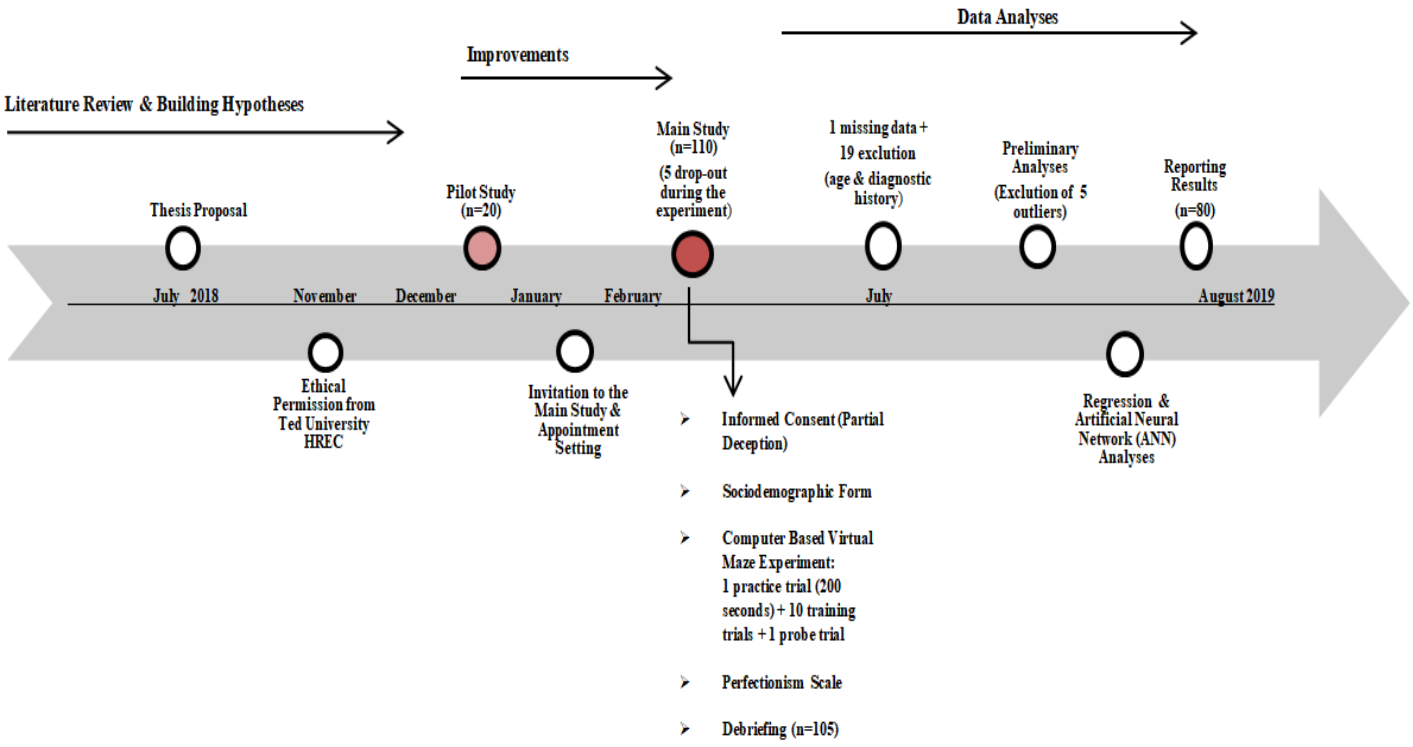


Figure 3. Timeline of the Thesis Project with Procedural Details

CHAPTER 3

MAIN STUDY

3.1 Method

3.1.1 Participants

Sixty- nine late adolescents and 41 young adults participated in the study. From late adolescence group, 5 participants left the experiment without completing.

The Participants who have a history of neurological and/or psychiatric disorder were excluded from the analysis. In addition, the ones who currently use any psychiatric and//or neurological medicine with or without prescription were excluded from the data as well. In total, 18 participants were excluded on these criteria.

One late adolescent was excluded because of her missing data and 1 adult was excluded since he exceeded the age criterion which is 36 as the maximum age. In sum, 20 participants (13 late adolescents and 7 adults) were excluded. Therefore, the data from 51 late adolescents (31 females and 20 males) (*M*= 21.0, *SD*= 1.3) and 34 adults (13 females and 21 males) (*M*= 31.4, *SD*= 2.7) were included in the preliminary analyses. The late adolescents were university students from different districts of Ankara. The majority of students were from TED University; following as Middle East Technical University, Ankara University, TOBB University of Economics and Technology and Baskent University. The

young adult sample was diverse in terms of professions. See Table 1. for details. Most of the young adults were graduates of Bachelor's Degrees (*n*=20); followed by Master's Degree (*n*=11), Ph.D. (*n*=2) and high school (*n*=1).

Profession	*n*
Academician	2
Biologist	1
Computer Programmer	1
Creative Director	1
Civil Servant	1
Engineer	6
Foreign Affairs	1
Freelancer	2
Inspector	1
Insurer	1
Journalist	1
Musician	3
Physiotherapist	1
Research assistant	1
Sales represent	1
Student	1
Teacher	1
Technician	4
Unemployed	3
Volunteer	1
Total	34

Table 1. Details for Professions of Young Adult Group

3.1.2 Materials

Sociodemographic Form. This form asks information about participants' date of birth, gender, type of profession and education level. It also asks if they have a history of any psychiatric and/or neurological disorder and information for usage of psychiatric drugs See Appendix B.

Perfectionism Scale. Turkish adaptation of Frost Multidimensional Perfectionism Scale (MPS-F) was used to measure perfectionism (Sayıl et al., 2012). The

original scale was developed by Frost et al., 1990 and consists of 35 items and 6 subscales. The Cronbach alpha levels for each subscale are: .88 for *Concern over Mistakes*, .83 for *Personal Standards*, .84 for *Parental Expectations*, .84 for *Parental Criticism*, .77 for *Doubts about Actions* and .93 for *Organization.*

Sayıl et al. (2012) adapted two versions of the scale for Turkish population as Adolescent Scale (ages between 13 and 19) and Adult Scale (ages >19). Considering the age range of the participants (18-23 and 27-36), Adult Scale was selected. Sayıl et al. (2012) suggests excluding items 4, 12, 19, 24, 34 and using the scale as a 5 subscale. The subscales are: *Organization/Personal Standards* (items 2, 7, 8, 27 and 31); *Concern Over Mistakes* (items 9, 10, 13, 14, 18, 21 and 23); *Parental Expectations* (items 1, 11, 15, 20 and 26); *Doubts about Actions* (items 17, 28, 32 and 33) and *Parental Criticism* (items 3, 5, 22 and 35). This scale can also be used to calculate maladaptive and adaptive perfectionism scores. Maladaptive perfectionism refers to the total score of *Concern over Mistakes*, *Parental Criticism* and *Doubts about Actions.* To calculate maladaptive perfectionism score, item 34 should be added to the analyses. Adaptive perfectionism refers to the total score of *Organization/Personal Standards*. See *Appendix C.* The Cronbach alpha level for the subscales are: .81-.82 for *Concern Over Mistakes*, .82-.87 for Organization/Personal Standards, .79-.81 for *Parental Expectation*, .63-.69 for *Parental Criticism*, .66-.68 for *Doubts about Actions*. (Sayıl et al., 2012). The Kaiser- Meyer- Olkin (KMO) value for the Adult form is .81 which refers to a good sampling adequacy (Kaiser, 1974).

Maze. The maze had the same dimensions with the one in the pilot study: It was created with Maze Maker software (Ayaz et al., 2008), based on the multiple T maze paradigm of Schmitzer- Torbert (2007) which has dimensions of 96 units x 83.2 units. It includes 4 symmetrical arms and a main hallway having a width of 6.4 units. There are also two symmetrical starting arms of the maze; each has width of 3.2 units. The texture, colors and light was upgraded according to the feedbacks from the pilot study: Instead of using plain tones of main colors on maze arms, we chose 4 different colored brick textures from pastel and secondary

colors. The textures were downloaded from https://textures.com (2019). Also the walls of the starting arms had different wall textures from each other. The walls in the opposite sites of the main hallways were selected different tones of the same color; the walls on the first starting point side were the tones of brown/dark orange and the walls on the second starting point side were the tones of dark blue/green. Finally, the color of the connection walls between main hallway and each 4 arms were dark grey. There were 4 doors to provide environmental cues; two of them were located at the opposing wall of starting point 1.This wall had a brick texture which was made of tones of orange. Other two doors were located crosswise on the direction of starting position 2. This wall had brick texture which was colored with tones of dark blue and green. We replaced skybox view with a ceiling and replaced grass floor with wood parquet. The brightness of ambient color was decreased and natural yellow light was set. Also, we added two additional cues; in front of the opposing wall of starting point 1, a coffee table was placed and in front of the opposing wall of starting point 2, a dining table was placed. For pictures from the inside of the maze see Figure 4. Also, 4 randomized conditions were created in which the chair appears in 4 possible places (Figure 5*).*

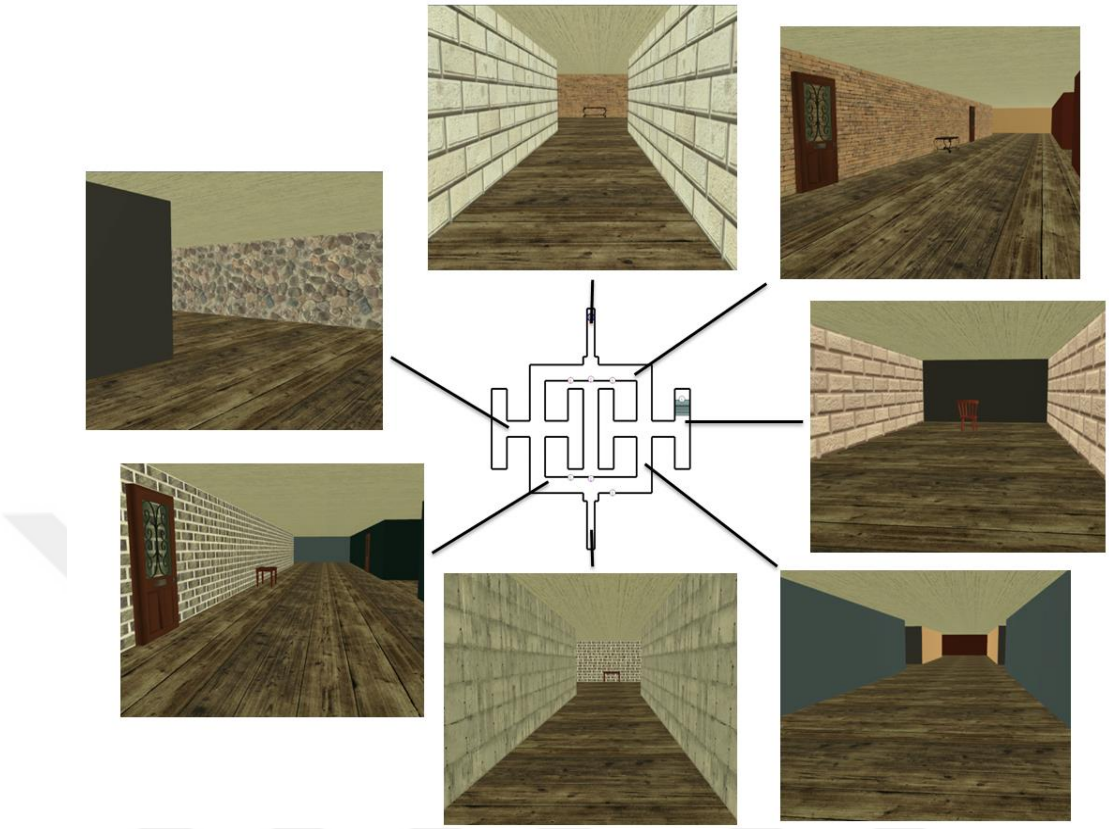


Figure 4. The Scenes of the Maze from Condition 1.

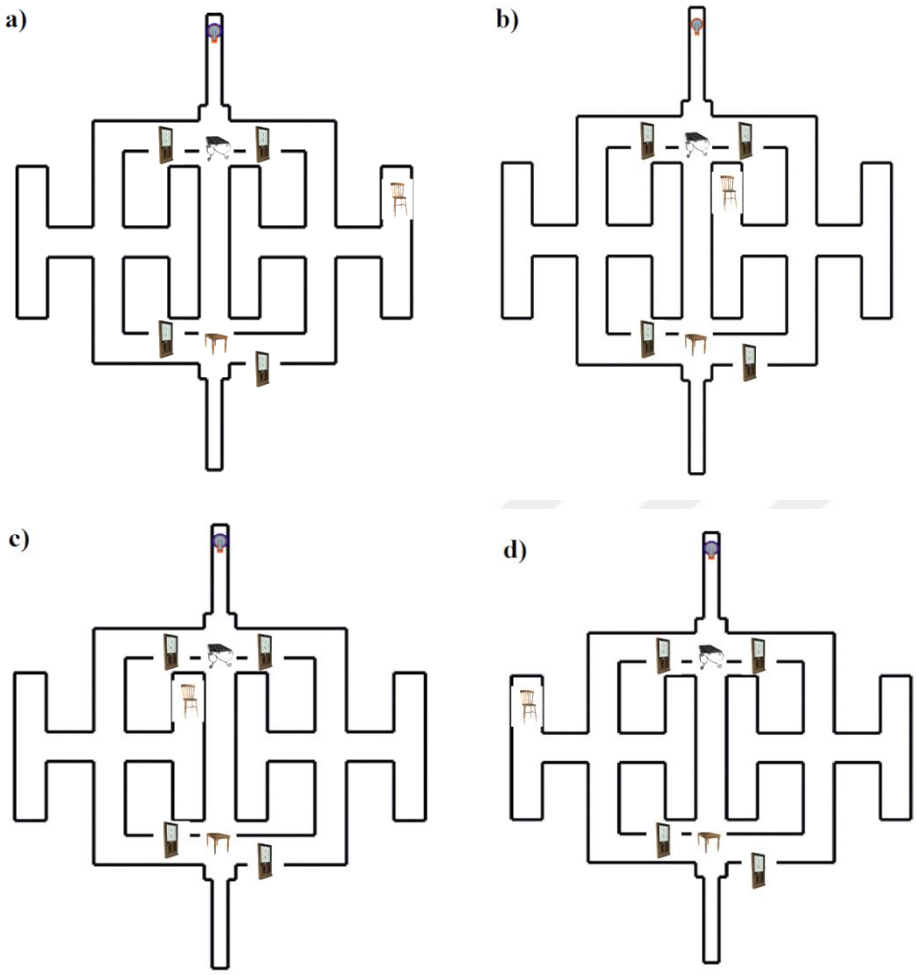


Figure 5. The Representation of Cues and the Target Object for the Pilot Study. The experimental and probe trials of the pilot study in different conditions follows as: a) condition 1 b) condition 2 c) condition 3 d) condition 4. In the practice trials of each condition, the chair was not present. In probe trials, the participants started from the opposite arm of the maze.

3.1.3 Procedure

Invitation to the study was made with snowball technique; by sharing the invitation on online platforms (facebook, instagram, linkedin and whatsapp) and asking individuals to share it on their online platforms. In addition, two lecturers from the psychology department and one lecturer from the mechanical engineering department of TED University announced the study to their students. For the invitation letter, see Appendix D. The aim of the study was partially explained to the participants on the invitation letter by saying that the study investigates *the link between learning processes and personality characteristics.*

Five undergraduate students from psychology department volunteered for help in data collection. An information meeting about the research project was organized and each of the volunteers received training about the data collection on separate times.

The individuals who accepted participation in the study were given an appointment. On their appointment time, the participants came to the Comparative Cognition Laboratory at TED University. For every participant, a participation number was assigned. For undergraduate students, three decimal numbers were given. This first decimal determined which of the 4 possible condition (chair appears in 4 possible places) each participant would be tested. For instance; a student with participation number 310 means that the participant was tested in condition 3, and he/she is the 10^{th} participant tested in this condition. For young adults group, four decimal numbers were given. The first decimal again determined the condition; an adult with a participation number 1003 refers to being 3^{rd} participant in condition 1. The numbers were assigned according to the time of participation to the study in an order of 101, 201, 301, 401,102, 202, 302, etc. for students; 1001, 2001, 3001, 4001, 1002, 1003 etc. for adults. The aim of this assignment procedure is to randomize conditions while minimizing the risk of a participant teaching the place of the chair to the next participant.

Firstly, the participants were asked to fill out informed consent form. According to the feedbacks from the pilot study, I added a section to the informed consent in order to inform participants about *the movement and bright colors that they will see on the screen; therefore, if they have any sensitivity or a special condition (e.g. epilepsy, migraine and vertigo), they may choose not to participate to the experiment* (see Appendix E).

Secondly, they filled out sociodemographic form (Appendix B). After filling out the forms; they sit in front of the computer. Every participant completed 1 practice trial, 10 experimental trials and 1 probe trial in total. The maze started with a verbal instruction as follows (See Appendix F for the original Turkish instructions):

Firstly, I am going to start the maze. You are going to see written instructions on the screen that explains what you are required to do. After reading every instruction, click on the OK button to move on to the next scene which can sometimes last 2-3 seconds to load. When you are finished, let me know and I am going to open the survey. After this instruction, the experimenter started the maze part of the experiment in Maze Walker software (Ayaz et al., 2008). The following written instructions appeared orderly and required participants to click on "OK" button to move on to the next one:

1- *The experiment starts with the practice trial. Get used to the control buttons while walking through the maze. After 3 minutes, the practice trial automatically ends.*
2- *W-A-S-D buttons on the keyboard enable the movement to different directions. The mouse control changes the direction of the gaze.*
3- *When you are ready, click on the OK button to start the practice trial.*

When the practice trial finished, instruction on the screen appeared as:

1- *The practice trial just finished, click on the OK button to see the instruction for the experimental trials.*

2- *In the experimental trials, you are required to find a chair located in the maze. You will be asked to find the chair for 11 times. For each time you find the chair, you will earn +1 point. The experiment is going to end upon reaching 11 points.*
3- *When you are ready, click on the OK button to start the experiment.*

Each time the participants found the chair, they were informed about their points. In addition, a positive reinforcement was given such as "*Good Job*!", "*Perfect*!" and "*You made it*!". When 10 points were achieved, the participants were asked to find the chair for the last time, as part of the probe trial. When the probe trial ended, an informative instruction appeared as:

Succeeded! 11/11

Thank you for your participation.

After the maze part finished, the experimenter opened the perfectionism scale on the same computer and entered the participation number at the beginning of the scale. The scale took 5 minutes to complete on average. The total procedure of the experiment lasted 20-30 minutes on average with the longest 40 minutes and the shortest 10 minutes of completion time. Debriefing about the detailed research questions and hypotheses were given to the participants, right after the experiment via The Debriefing Form (see Appendix G). The psychology students received grade points their participation. Rest of the participants received a small chocolate at the end of the experiment. We also kindly asked each participant not to disclose information about the context and aim of the research to their friends/relatives until the end of the data collection term.

3.2 Analyses

3.2.1 Preliminary Analyses

The navigational strategy (response vs. place strategy) of each participant on the probe trials was observed and path lengths of these trials were measured via Maze Analyzer software (Ayaz et al., 2008). Path length measures have been

considered as a valid navigational performance measure in previous research (Richardson, Powers & Bosquet, 2011; Akinlofa, Holt & Elyan, 2014). Since the path length from the starting points to the target chairs were all the same for 4 conditions, the location of the chair was not defined as a separate variable.

In order to decide the type of navigational strategies on probe trials, I looked at the first three movements (i.e. right-left-left) of the participants on their probe trials. If these three movements were the same with the last training trials (trials where the learning was established), the strategy was coded as "response strategy". If the movements were different (the participant navigates through a new path), the strategy was coded as "place strategy". Participants' path lengths in the probe trials were measured and 5 outliers (2 SD +/- to the mean) were excluded for further analyses.

Firstly, the navigational strategy preferences were analyzed for both young adults and late adolescents group. Also, the frequencies of navigational strategies for both sexes within and between each group were analyzed via Chi-square analyses on IBM SPSS 22 software.

Secondly, 8 groups were defined according to gender, developmental stage and navigational strategy: 1) Late Adolescent Females/ Place Strategy 2) Late Adolescent Females/ Response Strategy 3) Late Adolescent Females/ Place Strategy 4) Late Adolescent Males/ Response Strategy 5) Young Adult Females/ Place Strategy 6) Young Adult Females/ Response Strategy 7) Young Adult Males/ Place Strategy 8) Young Adult Males/ Response Strategy. The examples of probe trials from each group are provided in Figure 6. Mean differences of each group on path lengths and total perfectionism scores were compared with One-Way ANOVA analyses.

3.2.2 Regression Analyses

In order to test whether navigational performance can be predicted based on perfectionism scores, a simple linear regression analyses were conducted. In these analyses; scores in 5 dimensions of FMPS [Organization and Personal

Standards (Adaptive Perfectionism), Concern Over Mistakes, Doubts about Actions, Parental Criticism, Parental Expectation] , Maladaptive Perfectionism and Total Perfectionism scores of each 8 groups were included to the model in order to see if any of them create variances in path lengths of the participants or not. Regression slopes of the eights groups were also compared to each other to see if the slopes were significantly differed from each other.

I used the approach utilized by Wuensch, Jenkings, and Poteat (2002) to test whether the regression slopes belonging to two different groups differed significantly.

First, each coefficient in question was transformed as follows:

$$r' = (0.5)\log_e[\frac{1+r}{1-r}]$$

Subsequently, the test statistic in transformed coefficients was computed as follows:

$$z = \frac{r1 - r2}{\sqrt{\frac{1}{n1-3}+\frac{1}{n2-3}}}$$

Subsequently, the t and the p values were obtained from the z score.

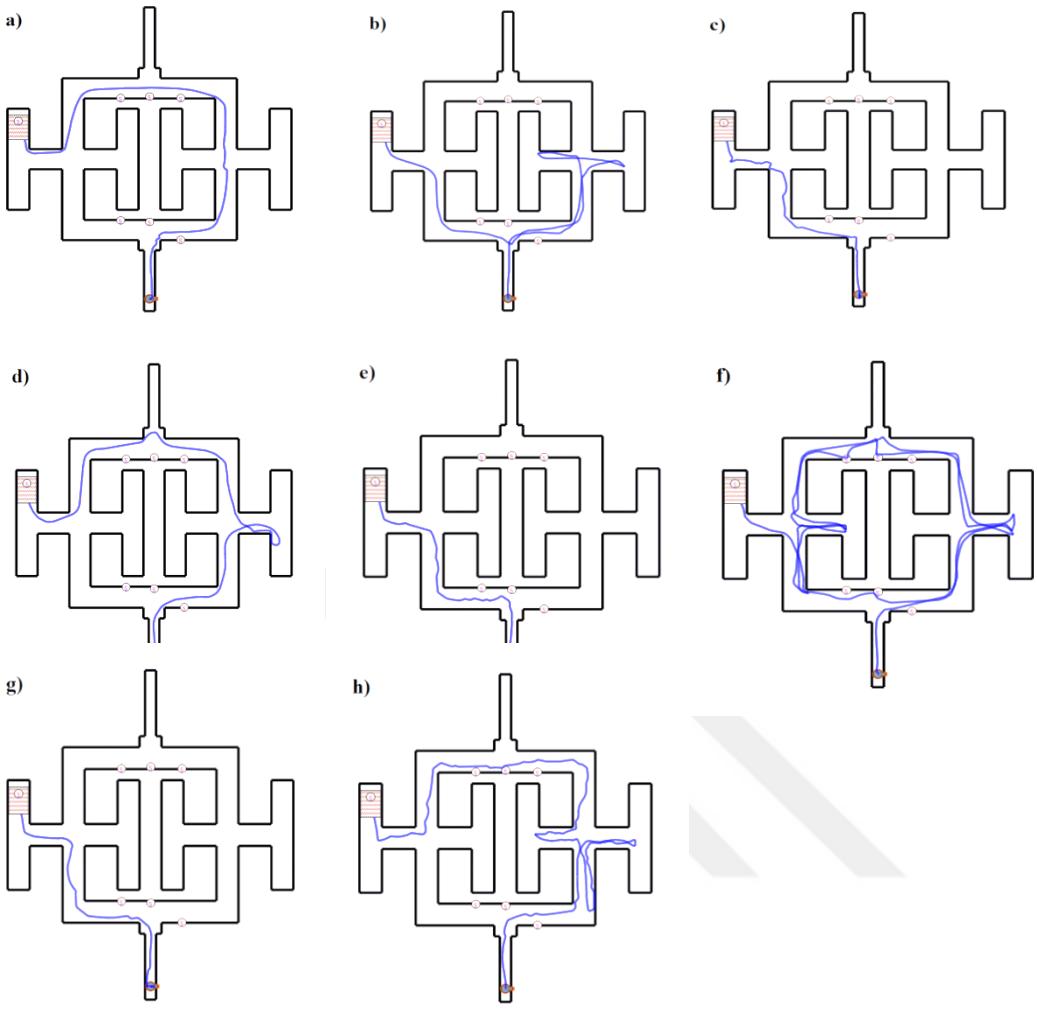


Figure 6. Examples from the analyses according to the probe trials in condition 4: a) Late Adolescent Females/ Place Strategy b) Late Adolescent Females/ Response Strategy c) Late Adolescent Females/ Place Strategy d) Late Adolescent Males/ Response Strategy e) Young Adult Females/ Place Strategy f) Young Adult Females/ Response Strategy g) Young Adult Males/ Place Strategy h) Young Adult Males/ Response Strategy

3.2.3 Artifical Neural Network (ANN) Analyses

To gain information from training trials themselves and see if they could predict both future behavior in the probe trials and the scores of the participants in the selected (according to their predictive power) perfectionism scores, two separate sets of analysis were conducted. In order to acquire mathematical measures and make predictions about the strategy use during a probe trial and perfectionism scores in different perfectionism subscales, artificial neural networks (ANNs) were implemented (see Figure 7 for a neural network diagram).

ANNs are basically inspired by biological neural networks where neurons communicate through synapses. Like the biological systems, ANNs are able to learn on the basis of identifying features fed through the input layer. In ANN, a real number corresponds to the input signal of an artificial neuron (node). The inputs to a node sum up in a nonlinear fashion to shape its output. The interface between two nodes is referred to as “edges” and corresponds to synapses in the biological systems. The weights of inputs to nodes as well as the thresholds of them get modified (i.e. strengthened or weakened) as learning proceeds, just as occurs in biological systems. A typical ANN is composed of different layers. These layers typically involve an input layer, a hidden layer, and an output layer. The information typically traverses back through backpropagation algorithms and forth as learning proceeds (Krenker, Bester, & Kos, 2011; Zurada 1992).

In this thesis, feedforward type of ANNs was implemented using 1-3 hidden layers depending on the purpose. These ANNs were employed to make use of machine learning algorithms that make classifications and predictions exploiting input data.

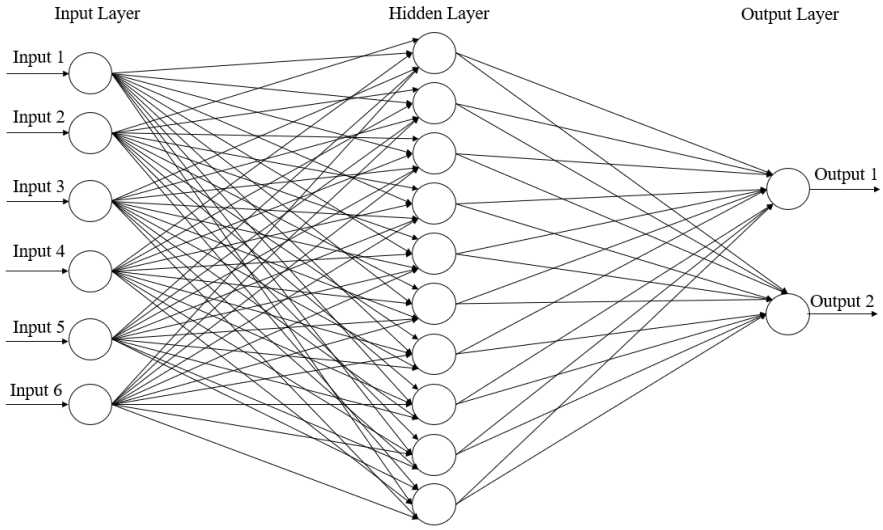


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Figure 7. Neural network diagram. Circles represent nodes and arrows indicate the connectivity among these nodes.

3.2.3.1 Classification of Response and Place Learners According to Training Trials

A 122 x 76 input matrix was implemented for predicting strategy use during the probe trials. Except the developmental stage and gender, the listed features below were presented to the ANN for each training trial in a recurring fashion (Figure 8): Mean values of x trajectory for each of the 10 trials, variance values (S.D.^{2}) of x trajectory for each of the 10 trials, SD of x trajectory for each of the 10 trials, minimum values of x trajectory of the 10 trials, maximum values of x trajectory of the 10 trials, mean values of z trajectory for each of the 10 trials, variance values (S.D.^{2}) of z trajectory for each of the 10 trials, SD of z trajectory for each of the 10 trials, minimum values of z trajectory of the 10 trials, maximum values of z trajectory of the 10 trials, total time for each trial.

RE) for each trial was calculated using the following formula:

REi=∑j=1k (pPAR, Llog (pPAR,L))/log(k). In the equation, pPAR,L is the probability of participant PAR being at location L. “k” represents the entire set

of conceivable places open to visit by the participants. In principle, RE measures the likelihood of being at a particular location at any given time. As RE values get higher, the behavior becomes less predictable

In the ANN procedures, 85 % of the data were used for training the network and the remaining 15 % of the data were used to tests. The input data were derived from histograms. For an example, see Figure 9.

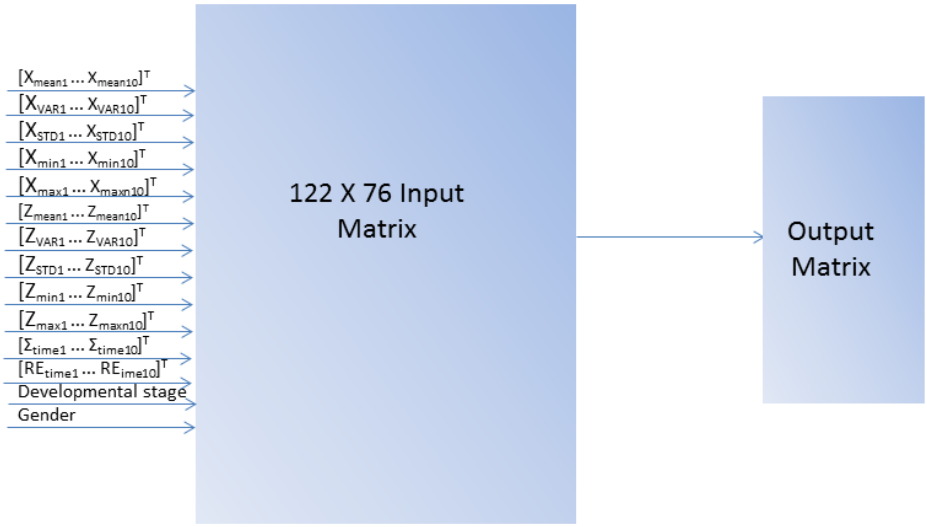

Figure 8. Input / Output matrix of the ANN being trained. Superscript T refers to transposition in style. VAR: Variance; STD: Standard deviation.

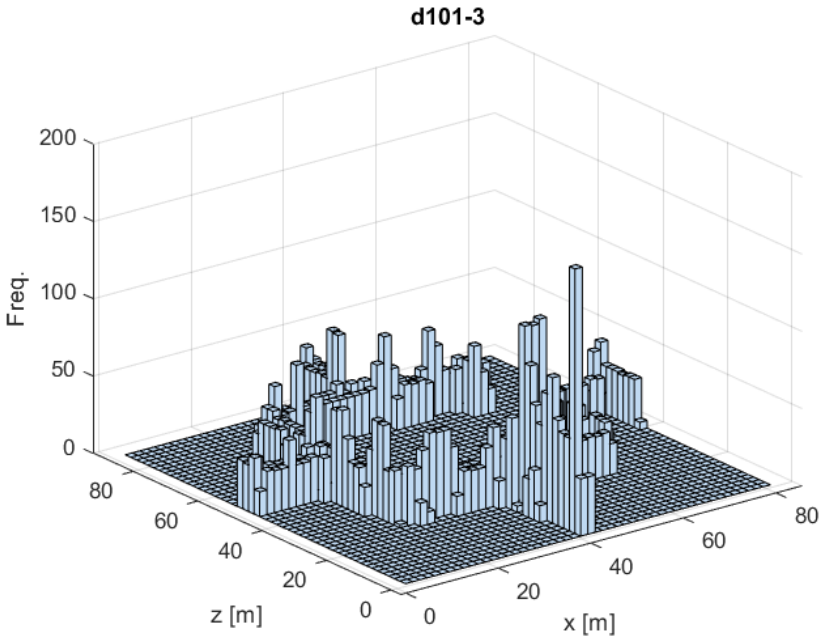

Figure 9. Representative histogram showing x and z trajectories for a participant.

3.2.3.2 Prediction of Perfectionism Scores from Training Trial Data

A 123 x 76 input matrix was implemented for predicting strategy use during the probe trial. Except the developmental stage and gender, the listed features below were presented to the ANN for each training trial in a recurring fashion as in the classification of place and response strategy users. Path length for each trial was added as an additional feature (Figure 10).

In the ANN procedures, 85 % of the data were used for training the network and the remaining 15 % of the data were used to tests. The input data were derived from histograms. For an example, see Figure 9.

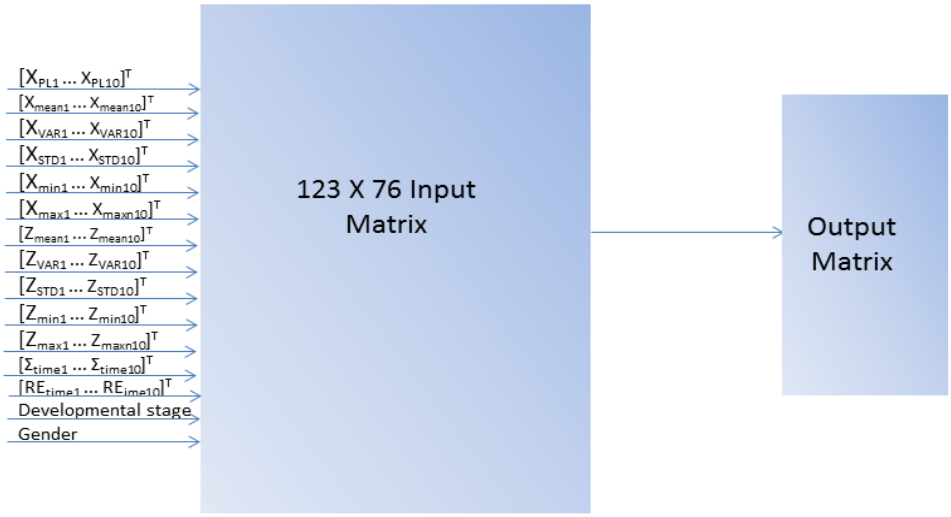

Figure 10. Input / Output matrix of the ANN being trained. Superscript T refers to transposition in style. PL: Path length; VAR: Variance; STD: Standard deviation.

3.3. Results

3.3.1 Sex and Developmental Differences on Navigational Strategies

As expected; the navigational strategies were almost equally distributed for both developmental stages. In late adolescents, 40% of the participants showed place strategy and 60% of the participants showed response strategy. In young adults, 47% of the participants showed place strategies and 53% of the participants showed response strategy. The Chi-square analyses showed that there is no

significant difference for preference of navigational strategies between late adolescents and young adults, $_X^2(1, n=80) = .418$, $p = .518$, $\Phi = -.072$.

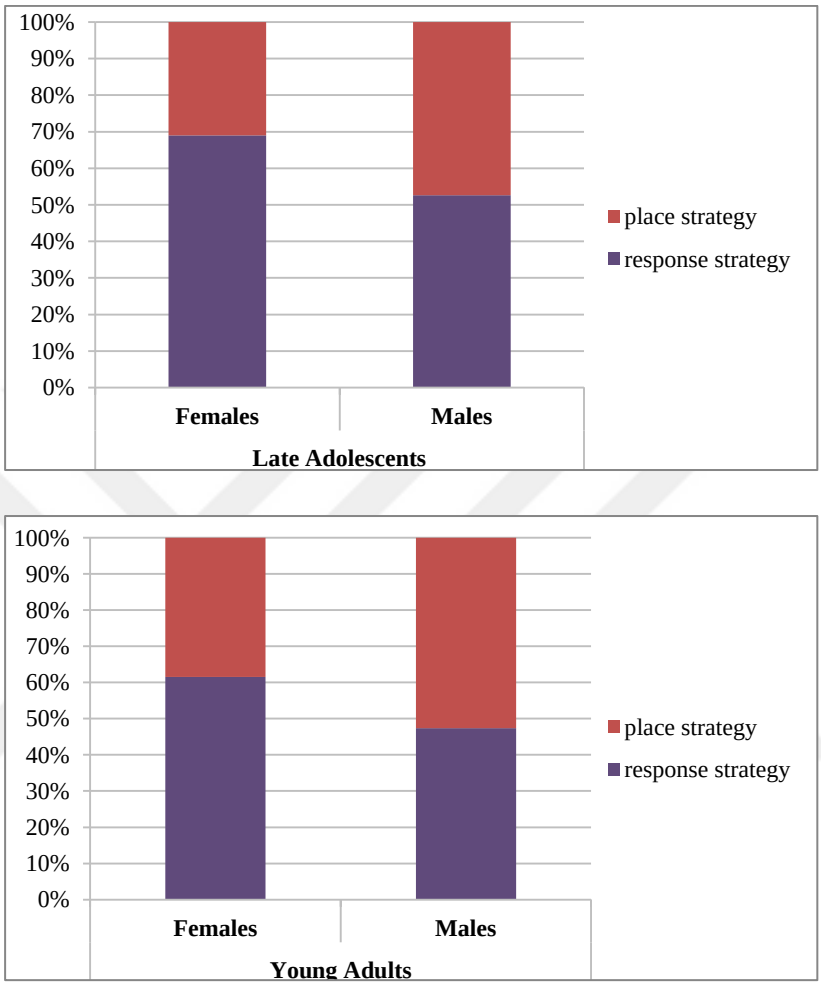

Figure 11. Navigational strategy usage within each developmental stage according to gender.

Analyses of the sex differences for navigational strategies showed that in late adolescents, there is no significant difference for navigational strategy preference between female and male participants, $_X^2(1, n=48) = 1.427$, $p = .232$, $\Phi = .216$. Also for young adult group, there is no significant difference for navigational strategy preference between female and male participants, $_X^2(1, n=32) = .183$, $p = .668$, $\Phi = .139$. Figure 11 represents the frequency distributions within each group.

3.3.2 Classification of Response and Place Strategy According to Training Trials

In a feedforward ANN with 2 hidden layers with 33 and 4 artificial neurons respectively, the ANN learned the training data with 98.4 % success for 62 subjects used. For the test, the network used 10 subjects (3 place and 7 response) and predicted the strategies used with 100 % accuracy. Overall, training and tests combined, the network could predict the strategy used with 98.6 % accuracy (Figure 12).

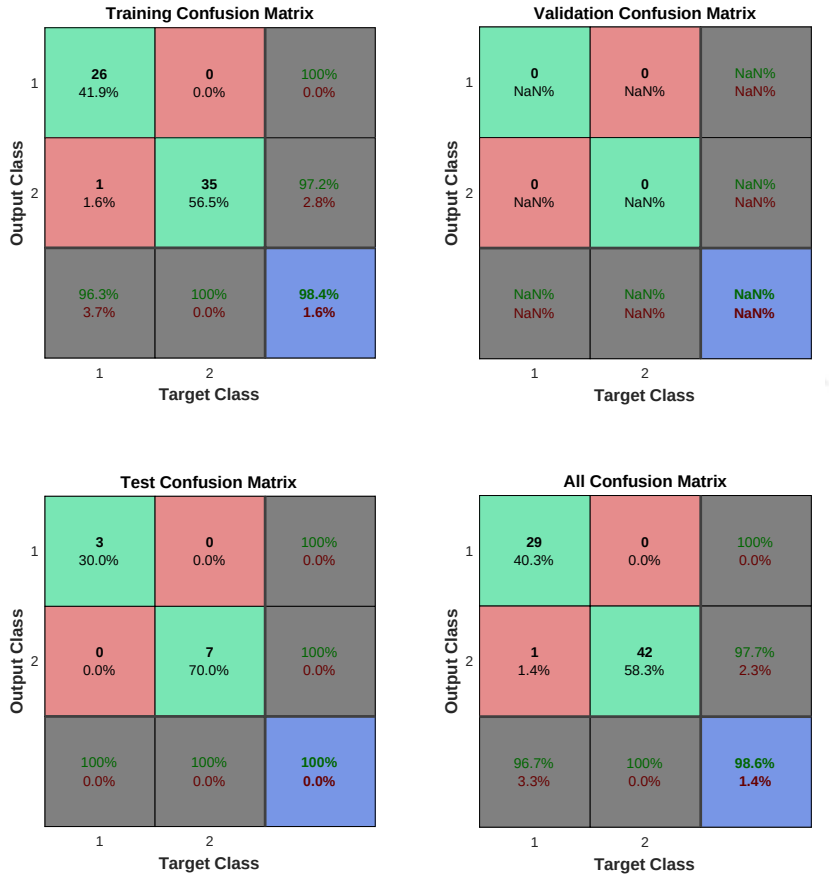

Figure 12. The ANN prediction of the response strategies considering training trials data. Results for the training, test, and combined data are represented. Validation matrix is empty because the model did not make use of the validation process. Output 1 class reflects place strategy users. Output 2 class reflects response strategy users. Green boxes reflect correct predictions, red boxes reflect incorrect predictions.

3.3.3 Mean Differences of Path Length and Total Perfectionism Scores

One-way ANOVA analyses showed that there are significant differences between eight groups on their path length means, F (7, 72) = 27, p <.001. Post Hoc analyses using Games-Howell indicated that Late Adolescent Females with place strategy and the ones with response strategy significantly differed on their path lengths means (p = .008). The same difference was also present among Late Adolescent Males (p= <.001). There is also a significant mean difference of path lengths between Late Adolescent Females with place strategy and Late Adolescent Males with response strategy (p < .001). Late Adolescent Males with place strategy and Late Adolescent Females with response strategy significantly differed on their path lengths means (p <.001).

Among Young Adult Females, there is no significant difference between participants with response strategy and the ones with place strategy on their path lengths (p=.38). However, Young Adult Females with response strategy significantly differed from Late Adolescent Males with place strategy (p=.14).

For Young Adult Males, there is a significant difference between participants with response strategy and the ones with place strategy on path lengths means (p<.001). There is also a significant difference on path lengths means between Young Adult Males with place strategy and Late Adolescent Females with response strategy (p <.001); and Late Adolescent Males with response strategy (p <.001). Lastly, there is a significant difference between Young Adult Males with response strategy and Late Adolescent Females with place strategy (p<.001). The descriptive are represented in Figure 13.

The analyses of variance indicate that there are no significant differences among eight groups on total perfectionism scores, F (1, 78) =.089, p=.766. The descriptive is presented in Figure 14.

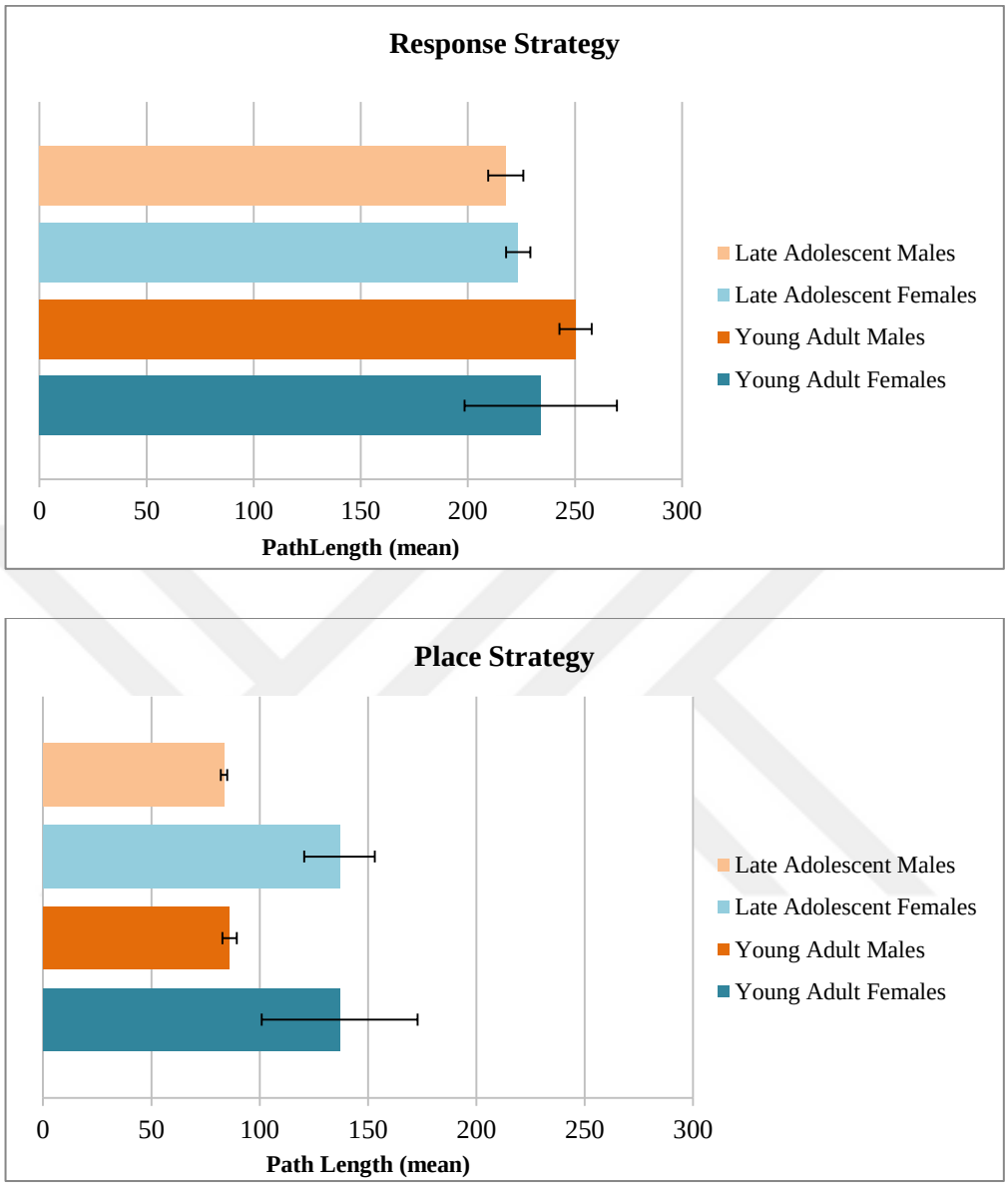

Figure 13. The mean and standard errors of the path lengths for response and place strategies. The error bars indicates standard error of the mean.

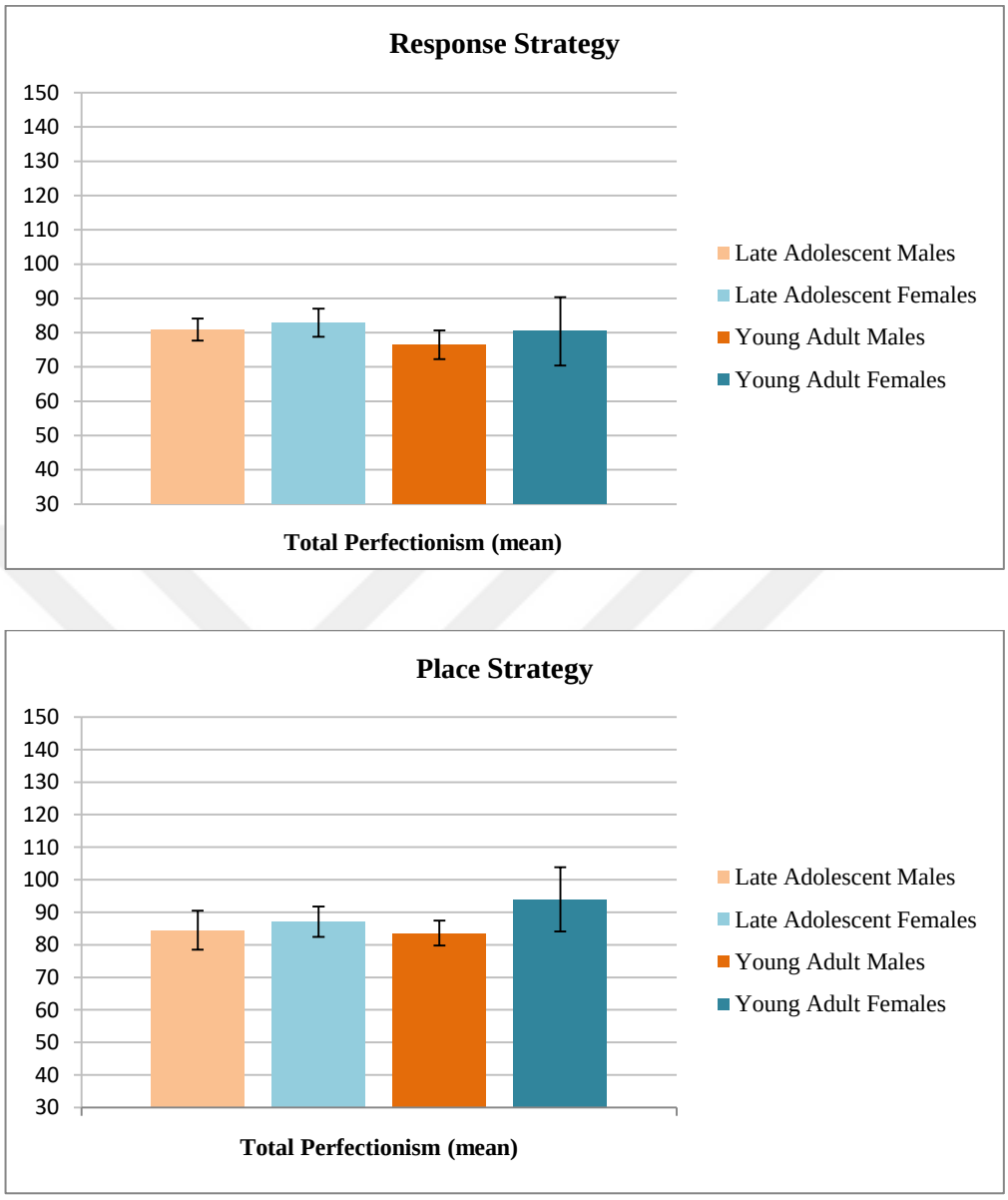

Figure 14. The mean and standard errors of total perfectionism score for response and place strategies. The error bars indicates standard error of the mean.

3.3.4 The Variances of Path Lengths based on Perfectionism Scores

Regression analyses showed that for Late Adolescent Males with place strategy, the scores on concern over mistakes dimension significantly created variances in path lengths, F (1,8) = 7.995, p=.022 with an R^2=.500. Participants' predicted path length is equal to 94.998 + (-).586 (concern over mistakes) unit when concern over mistakes is measured in points. Participant's path lengths decreased .586 for each point of concern over mistakes scores. Also, their scores on parental expectation dimension significantly predicted path lengths, F (1, 8) =8.964, p=.017 with an R^2= .528. Participants' predicted path length is equal to 93.229 + (-).704 (parental expectation) unit when parental expectation is measured in points. Participants' path lengths decreased .704 for each point of Parental Expectation scores. In addition, their scores on Parental Criticism dimension significantly predicted path lengths, F (1, 8) = 11.430, p=.010 with an R^2= .588. Participants' predicted path length is equal to 89.992 + (-).820 (parental criticism) unit when parental criticism is measured in points. Participants' path lengths decreased .820 for each point of Parental Criticism scores.

For also Young Adult Females with response strategy, there were significant regression equations with some of their perfectionism scores and path lengths: 1) Participants' scores on Parental Expectation significantly created variances in path lengths, F (1, 8) = 10.653, p=.017 with an R^2=.640. Participants' predicted path length is equal to 115.765+ 11.050 (parental expectation) unit when Parental Expectation is measured in points. Participants' path lengths increased .800 for each point of Parental Expectation scores. 2) Their scores on Doubts about Actions predicted path lengths, F (1, 8) = 3.112, p=.039 with an R^2=.534. Participants' predicted path length is equal to 76.223 + .651 (doubts about actions) unit when Doubts about Actions is measured in points. Participants' path lengths increased .529 for each point of Doubts about Actions scores. 3) Their scores on Parental Criticism significantly created variances in path lengths, F (1, 8) =21.628, p=.004 with an R^2= .783. Participants' predicted path length is equal to 146.876 + 13.330 (parental criticism) unit when Parental Criticism is measured in points.

Participants' path length increased .885 for each point of Parental Criticism scores. 4) Their Total Perfectionism scores significantly created variances in path lengths, F (1, 8) = 21.466 with an R^2= .782. Participants' predicted path length is equal to 19.165+ .3.144 (total perfectionism) unit when Total Perfectionism is measured in points. Participants' path lengths increased .884 for each point of total perfectionism scores. 5) Participants' Maladaptive Perfectionism scores dimension significantly created variances in path lengths, F (1, 8) =13.971, p=.010 with an R^2=.700. Participants' predicted path length is equal to 89.079 (maladaptive perfectionism) units when Maladaptive Perfectionism is measured in points. Participants' path lengths increased .839 for each point of Maladaptive Perfectionism scores.

Regression slope analyses indicated differences in slopes even in the cases where the p value for a particular regression was > 0.05. These cases are shown on regression comparison charts with red color coding for information purposes and will not be discussed further. The p- values are represented inside the boxes.

Regressions with p values of <0.05 are indicated in bold italics format. Not all regressions with p values of <0.05 exhibited different slopes. For regressions that reach significance and have different slopes from other regression lines, the boxes in the regression comparison charts are filled in blue. The t- and p-values for those comparisons are given below each respective chart accompanied by scatterplots.

Organization/Personal Standards (Adaptive Perfectionism)

Young Adult Female/ Place	NS						
Young Adult Male/ Response	NS	NS					
Young Adult Male / Place	0.033	NS	NS				
Late Adolescents Female / Response	0.0087	0.0434	NS	NS			
Late Adolescents Female / Place	0,0169	NS	NS	0.0342	0.0142		
Late Adolescents Male/Response	NS	NS	NS	0.9366	NS	0.0142	
Late Adolescents Male/ Place	0.0327	NS	NS	NS	NS	0.097	0.0455
VS.	Young Adult Female/ Response	Young Adult Female/ Place	Young Adult Male/ Response	Young Adult Male/ Place	Late Adolescent Female / Response	Late Adolescent Female/ Place	Late Adolescent Male/ Response

Table 2. Comparison Chart 1 [Organization/Personal Standards (Adaptive Perfectionism)]. Red filled boxes indicate two slopes exhibiting significant differences. None of the individual R^2s reached significance. NS represents non significance.

Concern Over Mistakes

Young Adult Female/ Place	NS						
Young Adult Male/ Response	NS	NS					
Young Adult Male / Place	NS	NS	NS				
Late Adolescents Female / Response	0.0476	0.0385	NS	NS			
Late Adolescents Female / Place	NS	NS	NS	NS	NS		
Late Adolescents Male/Response	NS	NS	NS	NS	NS	NS	
[1]Late Adolescents Male/ Place*	NS	NS	NS	NS	NS	NS	NS
VS.	Young Adult Female/ Response	Young Adult Female/ Place	Young Adult Male/ Response	Young Adult Male/ Place	Late Adolescent Female / Response	Late Adolescent Female/ Place	Late Adolescent Male/ Response

Table 3. Comparison Chart 2 (Concern over Mistakes). Red filled boxes indicate two slopes exhibiting significant differences. The R^2s reached significance for the bold italic cases. [1] $R^2 = .500$, $p = 0.022$ (*). NS represents non significance.

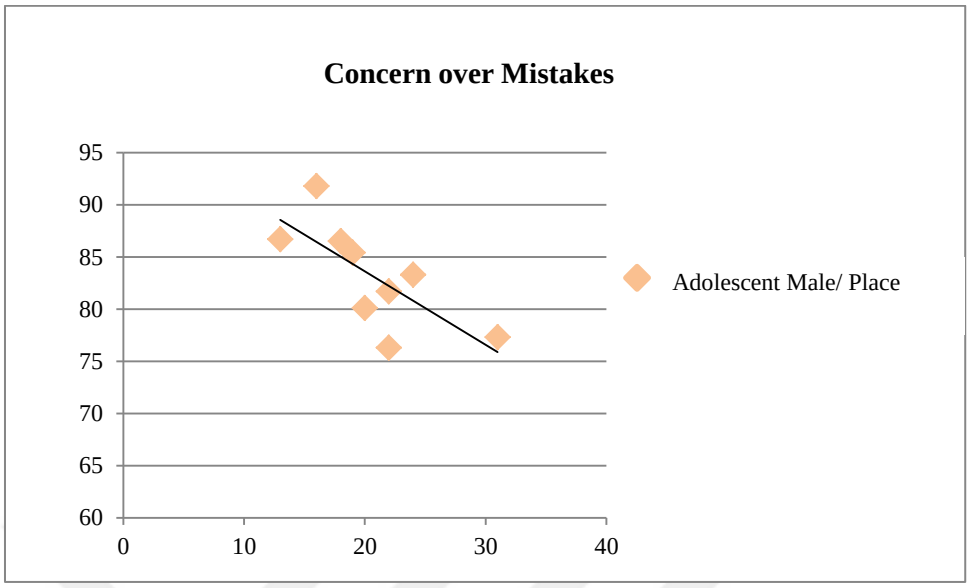

Figure 15 Scatter plot for #1 item from *Comparison Chart* 2. An increase in the score is associated with a reduction in path length corresponding to improved strategy use ($R^2 = 0.5$, $p = 0.022$).

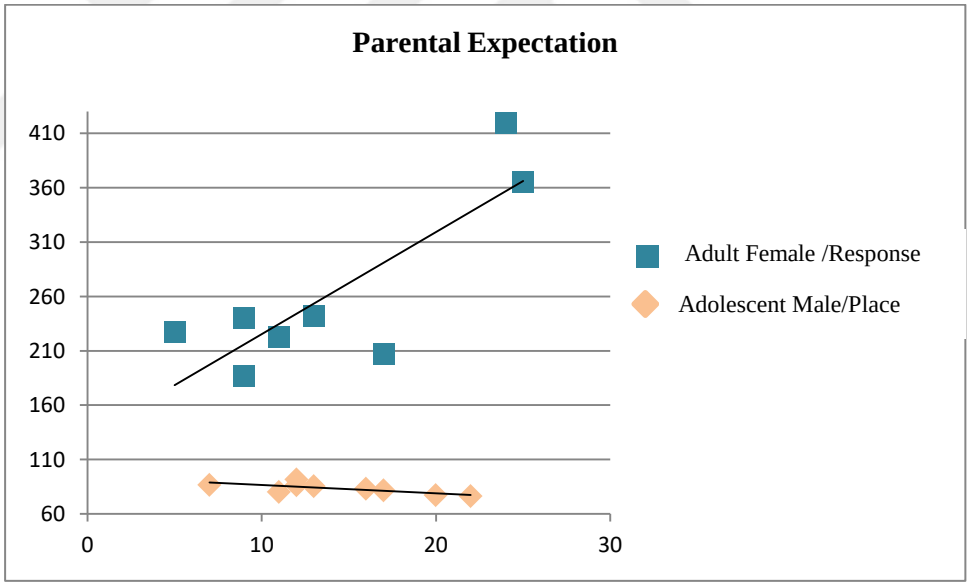

Figure 16 Scatter plot for #2 item from *Comparison Chart 3* comparing regression slopes for parental expectation and path length as a dependent variable. Slope for the Late Adolescent Male/ Place Strategy group is significant ($R^2 = 0.53$, $p = 0.017$). Slope for the adult female response strategy group is significant ($R^2 = 0.53$, $p = 0.017$). The regression slopes for the two groups are significantly different ($p = 0.012$).

Parental Expectation

Young Adult Female/ Place	NS						
Young Adult Male/ Response	[6][*]	NS					
Young Adult Male / Place	[5][*]	NS	NS				
Late Adolescents Female / Response	[4][**]	NS	NS	NS			
Late Adolescents Female / Place	NS	NS	NS	0.0373	0.0316		
Late Adolescents Male/Response	[3][*]	NS	NS	NS	NS	NS	
[1]Late Adolescents Male/ Place*	[2][*]	NS	NS	NS	NS	[1][*]	NS
VS.	***[2]Young Adult Female/ Response****	Young Adult Female/ Place	Young Adult Male/ Response	Young Adult Male/ Place	Late Adolescent Female / Response	Late Adolescent Female/ Place	Late Adolescent Male/ Response

Table 4. Comparison Chart 3 (Parental Expectations). Red filled boxes indicate two slopes exhibiting significant differences. The R^2s reached significance for the bold italic cases. [1] R^2 = .530, p = 0.017 (*) and [2] R^2 = .640, p = 0.017 (*). The two slopes differed in box numbers 1 [t (15) = 2.723, p = 0.026] (*), 2 [t (15) = 1.87, p = 0.012], 3 [t (15) = 4.963, p = 0.013], 4 [t (24) = 6.495, p = 0.0031], 5 [t (17) = 1.957, p = 0.0173], 6 [t (15) = 5.193, p = 0.04]. NS represents non significance.

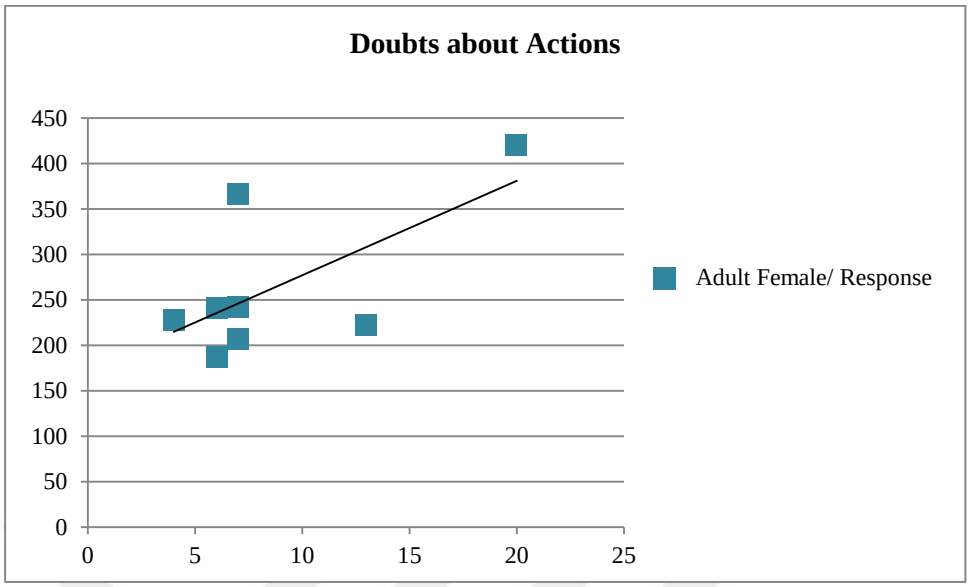

Figure 17 Scatter plot for #1 item from *Comparison Chart 4*. An increase in the score is associated with a concomitant increase in path length corresponding to impaired strategy use ($R^2 = 0.534$, $p = 0.039$).

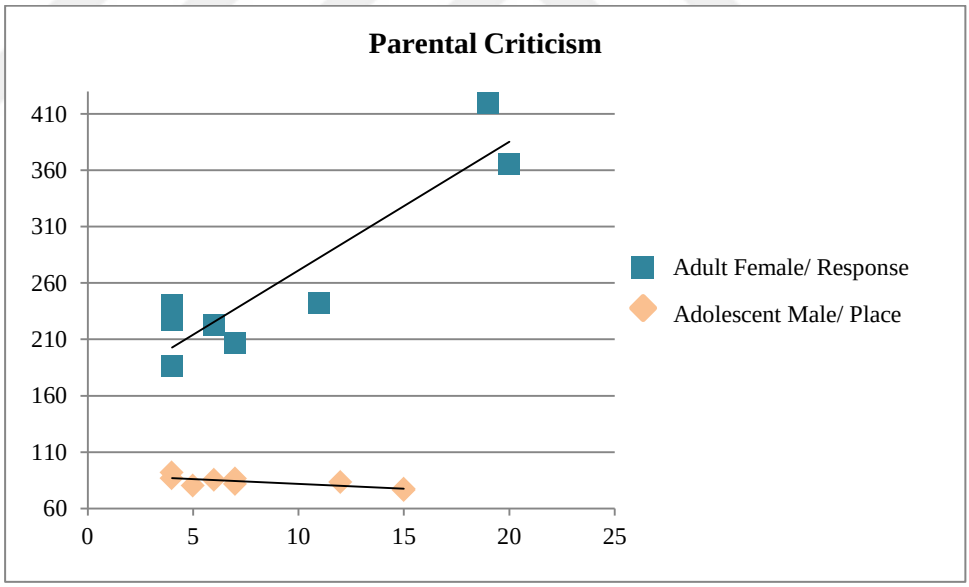

Figure 18. Scatter plot for #2 item from *Comparison Chart 5*. Comparing regression slopes for parental criticism and path length as a dependent variable. Slope for the adolescent male place strategy group is significant ($R^2 = 0.588$, $p = 0.001$). Slope for the adult female response strategy group is significant ($R^2 = 0.783$, $p = 0.004$) The regression slopes for the two groups are significantly different ($p = 0.001$)

Doubts about Actions

Young Adult Female/ Place	NS						
Young Adult Male/ Response	[4][*]	NS					
Young Adult Male / Place	[3][*]	NS	NS				
Late Adolescents Female / Response	[2][**]	NS	NS	NS			
Late Adolescents Female / Place	NS	NS	NS	NS	NS		
Late Adolescents Male/Response	NS	NS	NS	NS	NS	NS	
Late Adolescents Male/ Place	NS	NS	NS	NS	NS	NS	NS
VS.	***[1]Young Adult Female/ Response****	Young Adult Female/ Place	Young Adult Male/ Response	Young Adult Male/ Place	Late Adolescent Female / Response	Late Adolescent Female/ Place	Late Adolescent Male/ Response

Table 5. Comparison Chart 4 (Doubts about Actions). The R^2s reached significance for the bold italic cases. [1] R^2 = .530, p = 0.039. The two slopes differed in box numbers 2 [t (25) = 8.305, p = 0.002], 3 [t (17) = 1.652, p = 0.033], and 4 [t (16) = 5.620, p = 0.022]. NS represents non significance.

Parental Criticism

Young Adult Female/ Place	NS						
Young Adult Male/ Response	NS	NS					
Young Adult Male / Place	[5] [**]	NS	NS				
Late Adolescents Female / Response	[4] [**]	NS	NS	NS			
Late Adolescents Female / Place	NS	NS	NS	NS	NS		
Late Adolescents Male/Response	[3] [*]	NS	NS	NS	NS	NS	
[1]***Late Adolescents Male/ Place******	[2] [**]	NS	NS	NS	NS	NS	NS
VS.	***[2]Young Adult Female/ Response****	Young Adult Female/ Place	Young Adult Male/ Response	Young Adult Male/ Place	Late Adolescent Female / Response	Late Adolescent Female/ Place	Late Adolescent Male/ Response

Table 6. Comparison Chart 5 (Parental Criticism). The R^2s reached significance for the bold italic cases. [1] R^2 = .588, p = 0.001 [2] R^2 = 0.783, p = 0.004. The two slopes differed in box numbers 2 [t (16) = 3.544, p = 0.001], 3 [t (16) = 5.88, p = 0.011], 4 [t (25) = 8.891, p = 0.0055], 5 [t (17) = 3.258, p = 0.0022]. NS represents non significance.

Total Perfectionism

Young Adult Female/ Place	NS						
Young Adult Male/ Response	[6][*]	NS					
Young Adult Male / Place	[5][*]	NS	NS				
Late Adolescents Female / Response	[4][***]	NS	NS	NS			
Late Adolescents Female / Place	NS	NS	NS	NS	NS		
Late Adolescents Male/Response	[3][*]	NS	NS	NS	NS	NS	
Late Adolescents Male/ Place	[2][**]	NS	NS	NS	NS	NS	NS
VS.	***[1]Young Adult Female/ Response****	Young Adult Female/ Place	Young Adult Male/ Response	Young Adult Male/ Place	Late Adolescent Female / Response	Late Adolescent Female/ Place	Late Adolescent Male/ Response

Table 7. Comparison Chart 6 (Total Perfectionism). The R^2s reached significance for the bold italic cases. [1] R^2 = .782, p = 0.04. The two slopes differed in box numbers 2 [t (16) = 3.545, p = 0.002], 3 [t (16) = 2.125, p = 0.033], 4 [t (25) = 6.577, p = 0.000], 5 [t (17) = 0.793, p = 0.015], and 6 [t (16) = 2.924, p = 0.023]. NS represents non significance.

Maladaptive Perfectionism

Young Adult Female/ Place	NS						
Young Adult Male/ Response	[6] [**]	NS					
Young Adult Male / Place	[5] [*]	NS	NS				
Late Adolescents Female / Response	[4] [***]	NS	NS	NS			
Late Adolescents Female / Place	[3] [*]	NS	NS	NS	NS		
Late Adolescents Male/Response	NS	NS	NS	NS	NS	NS	
Late Adolescents Male/ Place	[2] [*]	NS	NS	NS	NS	NS	NS
VS.	***[1]Young Adult Female/ Response****	Young Adult Female/ Place	Young Adult Male/ Response	Young Adult Male/ Place	Late Adolescent Female / Response	Late Adolescent Female/ Place	Late Adolescent Male/ Response

Table 8. Comparison Chart 7 (Maladaptive Perfectionism). The R^2s reached significance for the bold italic cases.[1] R^2 = .699, p = 0.009. The two slopes differed in box number 2 [t (16) = 1.175, p = 0.030], 3 [t (16) = 2.389, p = 0.0160], 4 [t (25) = 8.239, p = 0.000], 5 [t (17) = 1.318, p = 0.019], 6 [t (16) = 5.656, p = 0.006]. NS represents non significance.

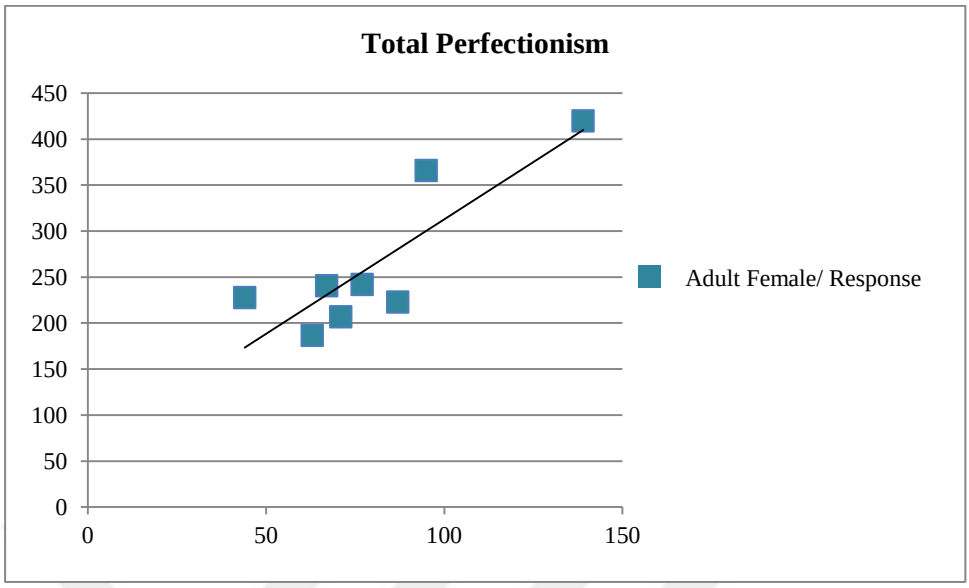

Figure 19. Scatter plot for #1 item from *Comparison Chart 6*. An increase in the score is associated with a concomitant increase in path length corresponding to impaired strategy use (R^2 = .782, p = 0.04).

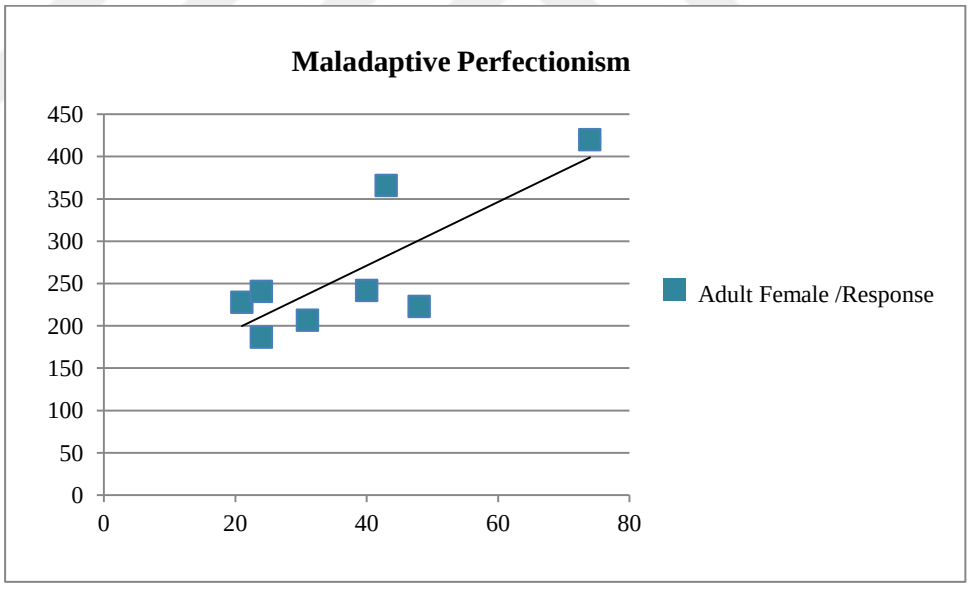

Figure 20. Scatter plot for #1 item from *Comparison Chart 8*. An increase in the score is associated with a concomitant increase in path length corresponding to impaired strategy use (R^2 = .699, p = 0.009).

3.3.5 Prediction of Perfectionism Scores from Training Trials Data

For organization/personal standards (adaptive perfectionism) scores; In a feedforward ANN with 3 hidden layers with 10, 2, and 10 artificial neurons respectively, the ANN could learn the pre-existing data with great ease as evidenced by a high correlation between the target (parental criticism) and output in the training phase (R = .87). The correlation between the target and output in the testing phase for 10 randomly tested participants dropped to moderate values (R = .55). Training and testing combined revealed an R value of .82 (Figure 21).

For concern over mistakes scores ; In a feedforward ANN with 3 hidden layers with 10, 2, and 10 artificial neurons respectively, the ANN could learn the pre-existing data with great ease as evidenced by a high correlation between the target (concern over mistakes) and output in the training phase (R = .99). The correlation between the target and output in the testing phase for 10 randomly tested participants dropped slightly but remained still high (R = .77). Training and testing combined revealed an R value of .96 (Figure 22).

For parental expectation scores; In a feedforward ANN with 3 hidden layers with 10, 2, and 10 artificial neurons respectively, the ANN could learn the pre-existing data with great ease as evidenced by a high correlation between the target (parental expectation) and output in the training phase (R = .99). The correlation between the target and output in the testing phase for 10 randomly tested participants dropped slightly but remained still high (R = .76). Training and testing combined revealed an R value of .95 (Figure 23).

For doubts about actions scores; In a feedforward ANN with 3 hidden layers with 10, 2, and 10 artificial neurons respectively, the ANN could learn the pre-existing data with great ease as evidenced by a high correlation between the target (doubts about actions) and output in the training phase (R = .94). The correlation between the target and output in the testing phase for 10 randomly tested participants dropped slightly but remained still high (R = .80). Training and testing combined revealed an R value of .90 (Figure 24).

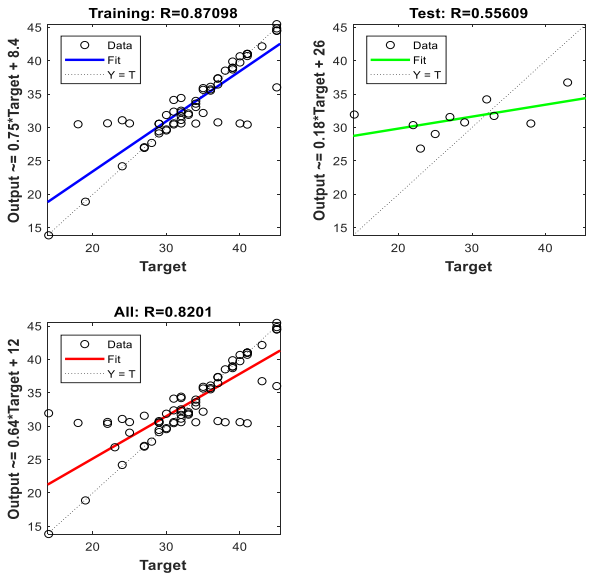

Figure 21. Regression values for the organization/personal standards (adaptive perfectionism) score obtained from the ANN. Measuring R values for a training and test phase along with both these phases combined.

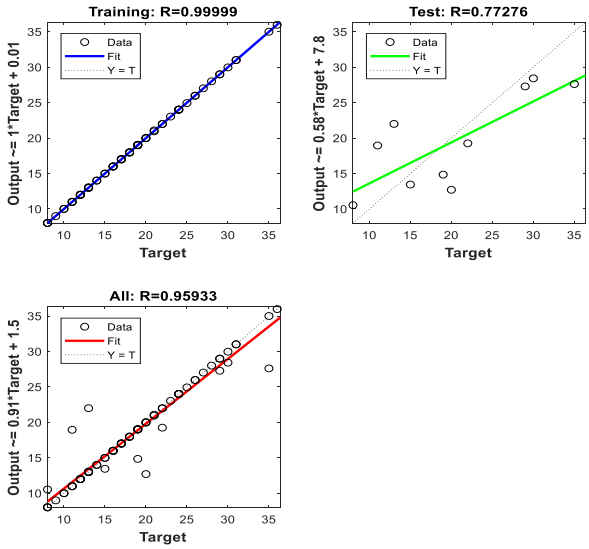

Figure 22. Regression values for the concern over mistakes score obtained from the ANN. Measuring R values for a training and test phase along with both these phases combined.

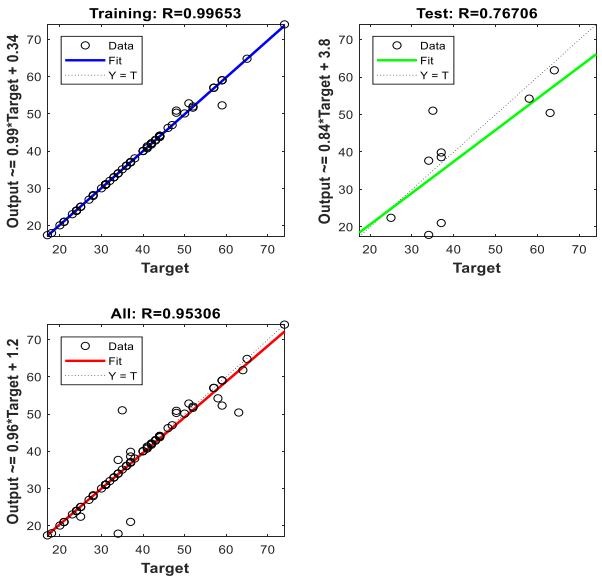

Figure 23. Regression values for the parental expectation score obtained from the ANN. Measuring R values for a training and test phase along with both these phases combined.

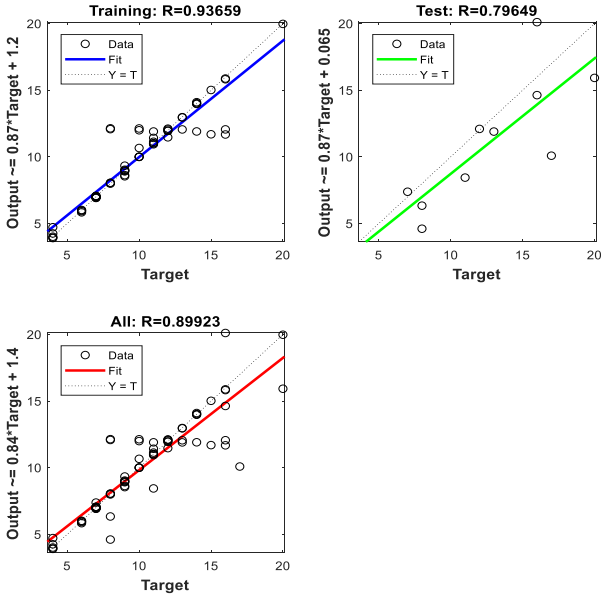

Figure 24. Regression values for the doubts about actions score obtained from the ANN. Measuring R values for a training and test phase along with both these phases combined.

For parental criticism scores; In a feedforward ANN with 3 hidden layers with 10, 2, and 10 artificial neurons respectively, the ANN could learn the pre-existing data with great ease as evidenced by a high correlation between the target (parental criticism) and output in the training phase (R = .99). The correlation between the target and output in the testing phase for 10 randomly tested participants dropped to moderate values (R = .59). Training and testing combined revealed an R value of .93 (Figure 25).

For total perfectionism scores; In a feedforward ANN with 3 hidden layers with 10, 2, and 10 artificial neurons respectively, the ANN could learn the pre-existing data with great ease as evidenced by a high correlation between the target (total perfectionism score) and output in the training phase (R =.99). The correlation between the target and output in the testing phase for 10 randomly tested participants dropped slightly but remained still high (R = .74). Training and testing combined revealed an R value of .91 (Figure 26).

For maladaptive perfectionism scores; In a feedforward ANN with 3 hidden layers with 10, 2, and 10 artificial neurons respectively, the ANN could learn the pre-existing data with great ease as evidenced by a high correlation between the target (maladaptive perfectionism score) and output in the training phase (R = .99). The correlation between the target and output in the testing phase for 10 randomly tested participants dropped slightly but remained still high (R = .76). Training and testing combined revealed an R value of .95 (Figure 27).

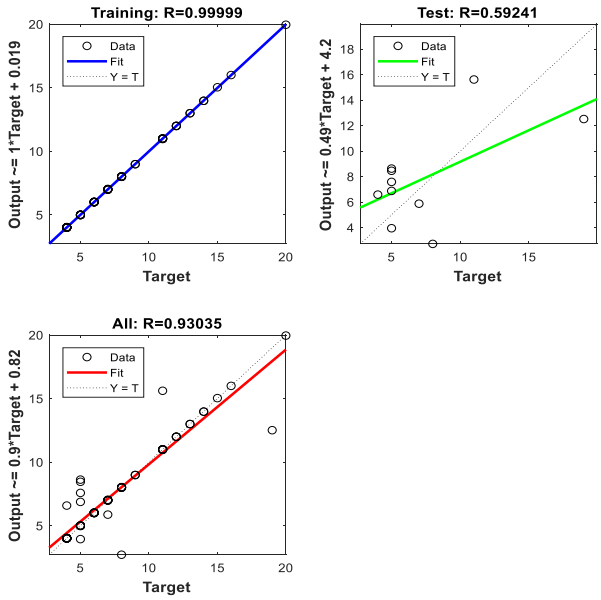

Figure 25. Regression values for the parental criticism score obtained from the ANN. Measuring R values for a training and test phase along with both these phases combined.

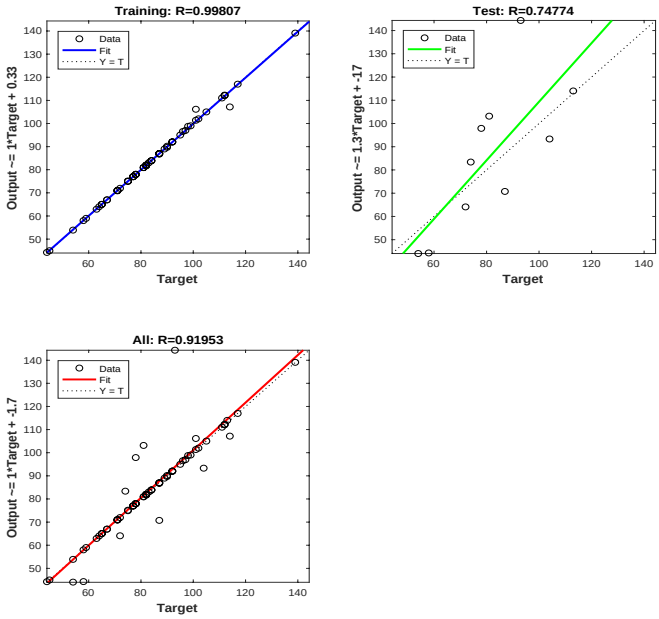

Figure 26. Regression values for the total perfectionism score obtained from the ANN. Measuring R values for a training and test phase along with both these phases combined.

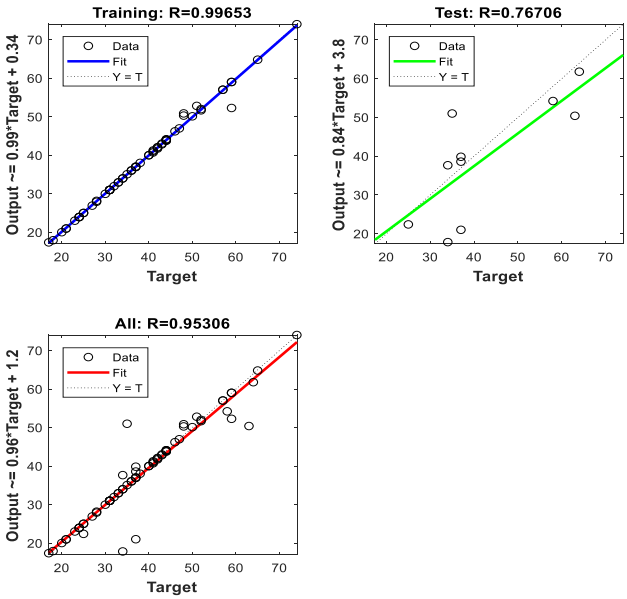

Figure 27. Regression values for the maladaptive perfectionism score obtained from the ANN. Measuring R values for a training and test phase along with both these phases combined.

CHAPTER 4

DISCUSSION

The present study aimed to investigate the possible link between perfectionism and navigational strategies in late adolescence from a comparative perspective. Literature suggests that assessing navigational strategies is an efficient way to observe the relative contribution of hippocampus and striatum in different behavior (striatum dependent learning for response strategy; hippocampus dependent learning for place strategy). It is a cardinal issue from a psychopathology perspective as well since these structures are also implicated in a wide variety of psychopathologies such as OCD, eating disorders, Tourette syndrome and autism spectrum disorder (Marsh et al., 2004; Goodman et al., 2014). This is not a straightforward issue as the literature also suggests sex differences for navigational strategies (Galea & Kimura, 1993; Lawton, 1994; Lawton, Charleston & Zieles, 1996; O' Laughlin & Brubaker, 1998; Chai & Jacobs, 2009; for a review, see Coluccia & Louse, 2004; Wolbers & Hegarty, 2010) in addition to potential sex differences in psychological predispositions. However, to my knowledge, there has not been any study looking at sex differences in navigational strategies in the light of perfectionism scores since perfectionism constitutes an additional risk factor for a variety of psychopathologies. Specifically, perfectionism is considered as a risk factor for developing psychopathologies like OCD, mood disorders, anxiety and eating disorders (Huggins et al., 2008; Shafran & Mansell, 2001; Egan, Wade & Shafran, 2011; Limburg, et al., 2016). Investigating the link between perfectionism and navigational strategies in late adolescence can provide important insights about the

development of psychological disturbances since late adolescence is a risky period for mental health (Lensi et al., 1996; Tükel et al., 2005; Ertan, 2008; Castello, Copeland & Angold, 2011; Steinberg et al., 2015; Auerbach et al., 2018). Accordingly, an experimental design using a computer-based virtual maze paradigm was established in order to observe the navigational strategies of the participants and analyzing it in the light of perfectionism scores. Specifically, the type of navigational strategy and the efficiency with which individuals utilize these strategies were measured. Along with an assessment of the participants' perfectionism scores using the Turkish adaptation of Frost Multidimensional Perfectionism Scale (Frost et al.,1990; Sayıl et al., 2012). In order to understand what is unique to the late adolescence period, the data were collected from a late adolescent and a young adult sample.

The preliminary analyses showed that the navigational strategies were almost equally distributed for both developmental stages, in line with previous findings (Iaria et al., 2003; Rodgers et al., 2012). Contrary to most of the studies in the literature (i.e. Galea & Kimura, 1993; Lawton, 1994; Lawton, Charleston & Zieles, 1996; O' Laughlin & Brubaker, 1998; Chai & Jacobs, 2009; for a review, see Coluccia & Louse, 2004; Wolbers & Hegarty, 2010), the strategy preference was distributed almost equally between two sexes. For the next analyses, eight groups were determined according to participants' sex, developmental stage and type of navigational learning: a) Late Adolescent Females/ Place Strategy b) Late Adolescent Females/ Response Strategy c) Late Adolescent Females/ Place Strategy d) Late Adolescent Males/ Response Strategy e) Young Adult Females/ Place Strategy f) Young Adult Females/ Response Strategy g) Young Adult Males/ Place Strategy h) Young Adult Males/ Response Strategy. The comparisons between these eight groups showed that except for young adult females, place strategy users showed better navigational performance as the navigational performance (i.e. path length to reach the target on a probe trial). Last but not the least, there was no difference between eight groups on their total perfectionism scores.

A lack of differences among groups is not very informative in itself. Hence, a more detailed analysis involving regressions were carried out to dissect the differential relationship among different perfectionism measures and how successfully the two different navigational strategies were implemented in different groups. A recurring theme has been that different perfectionism scores signified different outcomes for different groups. Among the perfectionism subscales, “concern over mistakes”, “parental expectation”, doubts about actions, and maladaptive perfectionism along with the total score were implicated in a strong relationship with the efficiency of navigational performance: regression analysis did not only point out to compelling results within single groups. As alluded to above, the steepness of these interactions also exhibited stark contrasts between groups. To tackle the complex question of what can be done with all these data, I considered artificial neural networks to delineate the potential function of these interesting relationships. As a first step in achieving this end, the results from artificial neural network training has revealed that behavior in the probe trial could be predicted from the behavior during training trials. As a second step, perfectionism scores were introduced into the picture: the behavior during training trials, which was enough for the neural network to predict the response strategy, were also informative in predicting scores obtained in perfectionism scales that exhibited prominent relationships with performance during the probe trial.

4.1. Sex and Age Differences in Determining Navigational Performance Related to Perfectionism

Differences in navigational performance related to perfectionism subscales were observed within and between the eight groups. For late adolescent males with place strategy, higher scores on the following perfectionism subscales increased navigational performance; concern over mistakes, parental expectation and parental criticism. Therefore, more efficient use of place strategy was evidenced by higher scores on these specific perfectionism subscales. In late adolescent male participants, higher scores on parental expectation were not only associated with increased navigational performance for place strategy but also, some sex

differences were observed related to that: The relationship for late adolescent males was even stronger then the corresponding relationship in late adolescent females. This suggests that higher scores in the perfectionism subscales is a far more significant predictor of navigational performance for late adolescent males compared to late adolescent females.

For young adult females with response strategy; lower scores on parental expectation, doubts about actions and parental criticism subscales increased navigational performance. In line with that, lower scores in maladaptive perfectionism and total perfectionism scores was related with higher navigational performance. It means that more efficient use of response strategy was evidenced by lower scores of these specific subscales/ dimensions of perfectionism. In young adult female subjects, lower scores in parental expectation were not only associated with more efficient use of response strategy. In addition, this relationship was even stronger than the corresponding relationship in late adolescent males. Therefore, scores in parental expectation is a far more significant predictor of navigational performance for females in young adulthood. Also, lower scores on doubts about actions were not only associated with more efficient use of response strategy for young adult females; some sex differences were also observed: The relationship was even stronger than the corresponding relationship in young adult male participants. Some developmental differences were also observed: The relationship was stronger for young adult females than the corresponding relationship in late adolescent females.

Lower scores on parental criticism were not only associated with more efficient use of response strategy for young adult females. In addition, some developmental differences were observed; more efficient use of response strategy depending on parental criticism scores was even stronger than the corresponding relationship in late adolescent males and females. Interestingly, this relationship was also stronger than the corresponding relationship in male participants who used place strategy from both developmental stages.

In young adult female participants, lower scores in total perfectionism were not only associated with more efficient use of response strategy. In addition, this relationship indicated developmental differences among females; more efficient use of response strategy depending on total perfectionism score was even stronger for young adult females than the corresponding relationship in late adolescent females. Sex differences were also observed: The relationship was even stronger than the corresponding relationship in male participants. Lastly, in young adult female participants, lower scores in maladaptive perfectionism were not only associated with more efficient use of response strategy. In addition, some developmental differences were observed: The relationship was even stronger than the corresponding relationship in late adolescent females. This suggests that maladaptive perfectionism is a far more significant predictor of navigational performance for females in young adulthood stage. Also, some sex differences were observed: the relationship between total perfectionism and navigational performance was even stronger than the corresponding relationship in young adult male participants. Interestingly, this relationship was also stronger than the corresponding relationship in male participants who used place strategy from both developmental stages. In short, it is evidenced that some of the interactions of sex and developmental stages created strong relationships for predicting navigational performance depending on perfectionism scores. These relationships were strongest for young adult females and late adolescent males.

4.2 Two Dimensional Structure of Perfectionism for Predicting Navigational Strategies

The literature suggests that perfectionism can be considered in a two dimensional structure named maladaptive/ adaptive perfectionism in predicting development of psychopathologies (Cox, Enns & Clara, 2002). According to that; concern over mistakes, doubts about actions and parental criticism subscales are part of maladaptive perfectionism. This idea has been controversial, especially for the etiology of OCD (Rice & Pence; 2006) and Eating Disorders (Stoeber & Otto, 2006; Sassaroli et al., 2008; Bardone-Cone et al., 2007). The results of our study

also contribute to this debate; the maladaptive subscales *Concern over Mistakes* and *Parental Criticism* played an adaptive role in navigational performances for late adolescent males with place strategy. It is a surprising result since the usage of place strategy suggests the involvement of hippocampus with flexibility in learning and has lower relationship with the etiology of psychopathologies (Gasbarri et al. 2014). However, the maladaptive perfectionism score, which also includes *Doubts about Actions* subscale in addition to *Parental Criticism* and *Concern over Mistakes*, of late adolescent males with place strategy was not correlated with navigational performance. Therefore, lower scores on *Doubts about Actions* may serve an adaptive role in navigational performance. More research is needed in order to understand this relationship.

On the contrary to late adolescent males with place strategy, maladaptive perfectionism score was negatively correlated with navigational performance of young adult females with response strategy. Therefore, the involvement of the striatum dependent learning which is related to inflexibility in actions was more prominent in this group and the performance was related with higher scores of maladaptive perfectionism. It may be possible that two dimensional structure of perfectionism has different consequences for different developmental stages and different sexes. Further research is needed in order to understand the validity of two dimensional structure of perfectionism from multiple memory systems perspective.

4.3 The Common Neurocognitive Structure in Understanding the Risks for Psychopathologies

The research questions of the current study are based on the notion that there may might a common underlying mechanism for specific learning mechanisms and risk factors for psychopathologies. This research area has received an increasing interest with the advances in multidisciplinary works between clinical psychology, neurobiology and cognitive neuroscience (Peterson, 2015).

Although perfectionism is acknowledged as a risk for psychopathologies, we have limited knowledge about its underlying and/or associated learning mechanism. Egan and colleagues (2011) claims that perfectionism has a transdiagnostic nature since it creates risk factors for several psychopathologies and also have a role in the co-occurrence of them on a single patient (Egan et al., 2011; Wheeler, Blankstein, Antony, McCabe & Bieling, 2011). This transdiagnostic nature of perfectionism can signal a common underlying neurocognitive structure of these psychopathologies. To my knowledge, this thesis is the first in the literature in terms of investigating perfectionism in multiple systems memory perspective. Even though it is too early to conclude, the results indicate that there can be a relationship between different dimensions of perfectionism and types of learning. More research is needed in order to understand this relationship for late adolescence period which is considered as a risky period for developing psychopathologies (Lensi et al., 1996; Tükel et al., 2005; Ertan, 2008; Castello, Copeland & Angold, 2011; Steinberg et al., 2015; Auerbach et al., 2018).

4.4 Clinical Implications

Finding a common underlying structure between perfectionism and navigational learning can provide us new methods for measurement. The assessment measures of perfectionism are still controversial in research and clinical practice (Shafran & Mansell, 2001; Stoeber & Otto, 2006) because of several reasons: First of all, measurement of perfectionism is based only on self-reports (Shafran & Mansell, 2001). Individuals may not be aware enough about their perfectionist ideas/ behaviors to report them accurately and/or they can report them in a biased way (King & Bruner, 2000; Van de Mortel, 2008). Secondly, the classification of the perfectionism subscales/dimensions has a weak validity across different samples (Egan, Piek, Dyck & Kane, 2011). Also, as it is mentioned before, maladaptive vs. adaptive classification of perfectionism has a low fit with the etiology of psychopathologies like OCD and Eating Disorders. This can prevent accurate assessments of these disorders and developing successful

intervention and prevention programs. Developing cognitive tasks (i.e. navigational strategies) in predicting risk factors (i.e. perfectionism) for psychopathologies can provide an implicit way for assessment, which may prevent the above mentioned problems (Wiers, Teachman, & De Houwer, 2007). An implicit way of measurement refers to a measurement procedure in which outcome is produced by participants without the awareness of the measurement goals, based on assessing their automatic cognitions or behaviors (Moors & De Houwer, 2006; De Houwer, 2006). The fact that training trials can predict both the navigational strategy and perfectionism scores by artificial neural networks strongly points out to one thing: that cognitive performance as assessed by navigational strategies and the way a perfectionism score is solved (hence potential risk factors for different psychological disorders) share a common biology and the related behavior (i.e. navigation) can be used as an implicit tool for assessing disorder risk. For instance; the behavior in training trials of individuals in a maze paradigm can be used to assess perfectionism levels. Further research is needed in order to develop implicit tools for perfectionism assessment specific to different samples such as teenagers vs. adults, women vs. men and clinical vs. non-clinical groups.

In addition to the possible benefits for measurement methods, understanding perfectionism from a more cognitive skill-set perspective in general and multiple systems perspective in particular can also lead advances for treatment methods. First of all, this notion will support the theory and practice of cognitive behavioral therapies. Cognitive-behavioral therapy (CBT) is one of the therapy methods in which the automatic dysfunctional thoughts and related behavioral responses of the patients are targeted during sessions (Fuchs, 2004) and perfectionist thoughts are one of these (Shafran, Cooper & Fairburn, 2002). In CBT models, perfectionism is considered as a maintenance factor for development of psychopathologies and a factor which decreases treatment success. Therefore, early treatment of perfectionist traits can be crucial for patients with risky profile for developing psychopathologies (Egan et al.,2011). Considering late adolescence period; as it was mentioned before, it is a period characterized with rapid neural

changes (Whitford et al., 2007; Levesque, 2011; Steinberg et al., 2015) along with significant life stressors (Zarrett & Eccles, 2006). Therefore, targeting perfectionism for late adolescent patients as a first step can be even more important. If the possible transdiagnostic nature of perfectionism can also be supported by implicit tools, better treatment models can be developed and the existing ones can be improved accordingly for patients with comorbid disorders. For instance; rather than applying separate treatment models for each comorbid disorder, a common treatment model targeting perfectionism can be applied (Egan et al., 2011).

Along with the treatments techniques in therapy settings, with the neurocognitive information provided by implicit tools (i.e. navigational tasks), some behavioral interventions targeting perfectionism can be developed. For example; a recent study has shown daily playing of Mine Craft (a video-game including tasks while navigating in a virtual environment) has positive influences on hippocampal memory (Clemenson, Henningfield & Stark et al., 2019). In line with this logic, stimulating brain areas/connections related to the etiology of perfectionism through behavioral interventions might be beneficial. More research is needed in order to understand the exact neurobiological mechanism for perfectionism and develop behavioral interventions accordingly.

4.5 Limitations

The studies in the thesis have their limitations. Firstly, only one scale of measurement (i.e. FMPS) was used to measure perfectionism. Also, there was no scale of measurement to assess symptomatology of participants related to perfectionism. It was done in purpose of reaching more participants in a limited timeframe. In addition, since it is a new idea of research, the procedural part was kept as simple as possible to provide basic information about the link between perfectionism and navigational strategies. Further research can add more scales in order to increase the reliability of the assessments and validity of perfectionism assessment in the role of psychopathology development.

Another limitation of the study concerns the developmental aspect of the research findings. The studies in this thesis could not provide enough information about the developmental aspects of late adolescence in determining navigational performance depending on perfectionism scores. Neither regression nor artificial network experiments revealed significant insights unique to the developmental stage. Potential reasons for this might concern the limited set of psychological scales used, absence of tools such as electroencephalography and eye-tracking to increase the reliability of the behavioral data, and so on. Another complication might arise from comparing two developmental stages (late adolescence vs. early adulthood); the continuous process (i.e. human development) was categorized into two distinct parts. This type of categorization could prevent observing the developmental trajectory in a critical way. Therefore, a future longitudinal study can provide a richer observation.

Lastly, only non-clinical samples were tested for this thesis project. Investigating clinical samples related to perfectionism such as OCD, depression and eating disorder patients can also provide important information about the etiology of the psychopathologies related to multiple memory systems.

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APPENDICES

Appendix A. Instructions of the Maze Experiment (Pilot Study)

Labirent Deneyi için Yönergeler (Pilot Çalışma)

1- Deneyimiz öncelikle alıştırma aşaması ile başlayacaktır. Labirentin her yerini dolaşarak kontrol tuşlarına alışmaya çalışın. Bunun için 3 dakika süreniz olacak.
2- Klavyede bulunan: W-A-S-D tuşları farklı yönlere ilerlemenizi, Fare ise baktığınız yönü değiştirmenizi sağlar.
3- Alıştırma oturumuna başlamak için OK'a basınız.
4- Alıştırma oturumu sona erdi. Deney aşamasının yönergesini görmek için OK'a basınız.
5- Deney aşamasında sizden labirentte bulunan sandalyeyi bulmanız istenecektir. Sandalyeyi her buluşunuzda +1 puan kazanacaksınız.10 puana ulaştığınızda son kez sandalyeyi bulmanız istenecektir. Sonrasında deney sonlanacaktır.
6- Buldun:) Tekrar Dene!1 / 10

   Bravo:) 2 / 10

   Harikasın :) 3 / 10

   Süpersin :) 4 / 10

   Bravo;) 5 / 10

   Süper:) 6/10

   Çok iyi gidiyorsun ! 7/10

   Bravo! 8/10

   Çok az kaldı :) 9/10

   Bravo! 10/10 Şimdi son kez bul!

   Başardın ! Katıldığın için teşekkür ederiz :)

Appendix B. Sociodemographic Form

Sosyodemografik Bilgi Formu

1) Doğum tarihi (Gün/Ay/Yıl): ……. /……. /……..

2) Cinsiyet: □ Kadın □ Erkek □ Belirtmek İstemiyorum

3) Meslek: …….

4) Eğitim Düzeyi: (En son alınan mezuniyet derecesi)

□ İlköğretim

□ Lise

□ Ön Lisans

□ Lisans

□ Yüksek Lisans

□ Doktora

□ Doktora Sonrası

5) Daha önce bir uzman doktor, psikiyatrist ya da psikolog tarafından herhangi bir psikiyatrik ve/veya nörolojik tanı aldınız mı?

□ Evet (açıklayınız: tanı ismi, ne zaman tanı konulduğu vb.)

……

……

……

……

□ Hayır

6) Tanıya bağlı veya tanı olmaksızın herhangi bir psikiyatrik ve/veya nörolojik ilaç kullandınız mı? (Şu anda kullandıklarınız dahil).

□ Evet (açıklayınız: ilaç ismi ve işlevi, kullanım süresi vb.)

……

……

……

……

□ Hayır

7) Renk körlüğünüz var mı?

□ Evet

□ Hayır

Appendix C. Frost Multi Dimentional Perfectionism Scale

Frost Çok Boyutlu Mükemmeliyetçilik Ölçeği (Frost ve ark.,1990; Sayıl ve ark.,2012)

Aşağıda SİZİNLE ilgili bazı ifadeler yer almaktadır. Lütfen bu ifadeleri dikkatlice okuyun ve sizin için ne kadar geçerli olduğunu size uyan rakamı daire içine alarak belirtiniz.	Hiç katılmıyorum	Pek katılmıyorum	Ne katılıyorum ne katılmıyorum	Biraz katılıyorum	Tamamen katılıyorum
1. Anne-babamın benim için koyduğu hedef ve beklentiler çok yüksekti.					
2. Plan yapmak benim için çok önemlidir.					
3. Çocukken, işleri en iyi şekilde (mükemmel) yapamadığım için cezalandırılırdım.					
4. Kendim için yüksek standartlar belirlemezsem, ikinci sınıf bir insan olurum.					
5. Anne-babam hiçbir zaman hatalarımı anlamaya çalışmadılar.					
6. Yaptığım her şeye tam anlamıyla hakim olmak benim için önemlidir.					
7. Düzenli/tertipli biriyim.					
8. Planlı, programlı biri olmak için çaba gösteririm.					
9. Eğer yaptığım işte başarısız olursam, kişi olarak başarısızımdır.					
10. Eğer bir hata yaparsam üzgün olmam gerekir.					
11. Anne-babam benim her şeyde en iyi olmamı istediler.					
12. Birçok insana göre, daha yüksek hedeflerim vardır.					
13. Eğer birisi, bir işi benden daha iyi yaparsa, kendimi o işte tamamen başarısız hissederim.					
14. Kısmen başarısız olmam; tamamen başarısız olmam kadar kötü bir şeydir.					
15. Anne babam için sadece üstün başarı iyi bir sonuçtu.					
16. Çabalarımı bir amaca (hedefe) doğru yöneltmede çok iyiyimdir.					

17. Bir işi çok dikkatli yapsam bile, sık sık, o işi çok doğru yapmadığımı hissederim.					
18. Yaptığım şeylerde, en iyi olamamaktan nefret ederim.					
19. Çok yüksek hedeflerim vardır.					
20. Anne babam benden mükemmel olmamı beklerlerdi.					
21. Eğer bir şeyde hata yaparsam insanlar, beni olduğumdan daha beceriksiz düşüneceklerdir.					
22. Anne babamın beklentilerini karşılayabildiğim duygusunu hiçbir zaman hissetmedim.					
23. Eğer bir şeyi diğer insanlar kadar iyi yapmazsam, bu benim işe yaramaz bir insan olduğum anlamına gelir.					
24. Kendimle karşılaştırdığımda, diğer insanlar daha düşük yaşam koşullarından memnun gibiler.					
25. Yaptığım işte her zaman iyi olmazsam insanlar bana saygı duymazlar.					
26. Anne babamın, geleceğim hakkında beklentileri daima benimkilerden yüksekti.					
27. Düzenli/tertipli biri olmak için çaba gösteririm.					
28. Basit gündelik işleri bile iyi yaptığım konusunda sık sık kuşku duyarım.					
29. Düzen ve tertiplilik benim için çok önemlidir.					
30. Günlük işlerimi yaparken, çoğu insana göre, kendimden daha yüksek performans beklerim.					
31. Planlı biriyim.					
32. Yaptığım işte genellikle geri kalırım çünkü tekrar tekrar yaptığıma geri dönerim.					
33. Bir şeyi "tam" yapmak çok zamanımı alır.					
34. Ne kadar az hata yaparsam insanlar benden o kadar çok hoşlanacaklardır.					
35. Anne babamın standartlarını karşılayabildiğim duygusunu hiçbir zaman hissetmedim.					

Appendix D. Invitation Letter

Katılım Duyuru Metni

Sizleri; TED Üniversitesi, Gelişim Odaklı Klinik Çocuk ve Ergen Psikolojisi Yüksek Lisans Programı kapsamında, Dr. Öğr. Üyesi Çağrı Temuçin Ünal danışmanlığında yürütülen ve öğrenme süreçleri ile kişilik özellikleri arasındaki ilişkiyi inceleyen tez çalışmasına katkıda bulunmaya davet ediyoruz. Çalışmamız için 18-23 ve 30-35 yaş aralıklarındaki kadın ve erkek katılımcılar arıyoruz. Bilgisayar ortamında gerçekleşecek olan çalışma yaklaşık 20-30 dakika civarında sürmektedir. Eğer çalışmaya katılmak isterseniz asli.konac@tedu.edu.tr adresine mail atarak yüksek lisans öğrencisi Aslı Konaç ile iletişime geçebilirsiniz. İlginiz için şimdiden teşekkür ederiz.

Appendix E.: Informed Consent

Gönüllü Katılım Formu

Sayın Katılımcı,

TED Üniversitesi Gelişim Odaklı Klinik Çocuk ve Ergen Psikolojisi Yüksek Lisans programı öğrencisi Psikolog Aslı Konaç, Dr. Öğr. Üyesi Çağrı Temuçin Ünal'ın danışmanlığında öğrenme süreci ve kişilik özellikleri arasındaki ilişkiyi incelemek adına bu tez çalışmasını yürütmektedir.

Çalışmaya katılmayı kabul ettiğiniz takdirde, bilgisayar ortamında gerçekleşecek bir deneye alınacaksınız. Bu deney esnasında sizden sanal bir labirent düzeneğine yerleştirilen bir nesneyi bulmanız istenecektir. Deney aşamasından sonra ise size doldurmanız için bir ölçek verilecektir. Size verilecek olan bu ölçeği ve bilgisayar ortamında gerçekleştirilen uygulamaları tam ve doğru bir şekilde doldurmanız/tamamlamanız çalışmanın gidişatı açısından oldukça önemlidir. Deney başından sonuna kadar yaklaşık olarak 30 dakikanızı alacaktır.

Deney esnasında ekranda parlak ışık ve renklerin olduğu hareket içeren bir görüntüye bakıyor olacaksınız. Eğer herhangi bir hassasiyetiniz var ise (migren, epilepsi, vertigo vb.) deneye katılmamayı tercih edebilirsiniz. Göz bozukluğunuzun olması durumunda göz numaranıza uygun bir gözlüğün/lenslerin takılı olmasını önemle rica ederiz.

Bu araştırmada elde edilecek veriler sadece araştırmacılar tarafından yapılan bilimsel yayınlarda, sunumlarda ve eğitimlerde paylaşılacaktır. **Araştırma kapsamında tüm kişisel bilgileriniz ve verdiğiniz cevaplar gizli tutulacaktır.** Toplanan veriler şifreli bir bilgisayara isminiz silinerek kaydedilecek ve burada tutulacaktır.

Bu çalışmaya katılmak tamamen isteğe bağlıdır. Katıldığınız takdirde çalışmanın herhangi bir aşamasında herhangi bir sebep göstermeden çalışmadan ayrılma hakkına sahipsiniz.

Araştırma projesi hakkında ek bilgi almak istediğiniz takdirde lütfen araştırmayı yürüten Psk. Aslı Konaç ile iletişime geçiniz. (E posta: asli.konac@tedu.edu.tr).

Eğer bu araştırma projesine katılmayı kabul ediyorsanız lütfen aşağıdaki formu imzalayınız.

"Ben ..…… (Katılımcının Adı -Soyadı), yukarıdaki metni okudum ve katılmam istenen çalışmanın kapsamını ve amacını, gönüllü olarak üzerime düşen sorumlulukları tamamen anladım. Bu çalışmayı istediğim zaman ve herhangi bir neden belirtmek zorunda kalmadan bırakabileceğimi ve bıraktığım takdirde herhangi bir olumsuzluk ile karşılaşmayacağımı anladım. Bu koşullarda söz konusu araştırmaya kendi isteğimle, hiçbir baskı ve zorlama olmaksızın katılmayı kabul ediyorum."

Katılımcının:

Adı-Soyadı: …….....

İmzası: …….

Tarih: (gün/ay/yıl) : …….. /…… /…….

Araştırmaya katılımınız ve haklarınızın korunmasına yönelik sorularınız varsa ya da herhangi bir şekilde risk altında olduğunuza veya strese maruz kalacağınıza inanıyorsanız TED Üniversitesi İnsan Araştırmaları Etik Kurulu'na (0312 585 00 11) telefon numarasından veya iaek@tedu.edu.tr e-posta adresinden ulaşabilirsiniz.

Appendix F. Instructions of the Maze Experiment (Main Study)

Labirent Deneyi için Yönergeler (Asıl Çalışma)

1- Deneyimiz öncelikle alıştırma aşaması ile başlayacaktır. Labirentin her yerini dolaşarak kontrol tuşlarına alışmaya çalışın. Bunun için 3 dakika süreniz olacak. Süre bittiğinde otomatik olarak sonlanacaktır.
2- Klavyede bulunan: W-A-S-D tuşları farklı yönlere ilerlemenizi, Fare ise baktığınız yönü değiştirmenizi sağlar.
3- Alıştırmaya başlamak için hazır olduğunuzda OK 'a basınız.
4- Alıştırma sona erdi. Deney aşamasının yönergesini görmek için OK'a basınız.
5- Deney aşamasında sizden labirentte bulunan sandalyeyi bulmanız istenecektir. Sandalyeyi her buluşunuzda +1 puan kazanacaksınız. 11 puana ulaştığınızda deney sonlanacaktır.
6- Deney aşamasına başlamak için hazır olduğunuzda OK' a basınız.
7- Buldun:) Tekrar Dene! 1 / 11

   Bravo:) 2 / 11

   Harikasın :) 3 / 11

   Süpersin :) 4 / 11

   Bravo;) 5 / 11

   Süper:) 6 / 11

   Çok iyi gidiyorsun! 7 / 11

   Bravo! 8/11

   Çok az kaldı :) 9 / 11

   Süper! Şimdi son kez bul! 10/11

   Başardın! 11/11 Katıldığın için teşekkür ederiz :)

Appendix G. Debriefing Form

Katılım Sonrası Bilgilendirme Formu

Sayın Katılımcı,

Araştırmamıza katılarak verdiğiniz destek için çok teşekkür ederiz.

Bu araştırmanın amacı bireylerin mükemmeliyetçilik düzeyleri ile yön bulma stratejileri (mekânsal öğrenme ve etki-tepki öğrenmesi) arasındaki bağlantıyı araştırmaktır. Mekânsal öğrenmede bireyler bulmak istedikleri nesnenin konumunu bilişsel olarak haritalandırırlar ve ona göre gidecekleri yönü belirlerler. Etki-tepki öğrenmesinde ise bireyler nesneden çok kendi konumuna odaklanırlar; bundan dolayı kendilerini referans alarak öğrendikleri yön bulma davranışını gösterirler.

Hipotezimiz; daha yüksek mükemmeliyetçilik seviyesine sahip bireylerin yönlerini bulurken etki-tepki öğrenmesine dayalı davranış göstereceği yönündedir. Araştırma ile ilgili daha ayrıntılı bilgi almak ve araştırma sonuçlarından haberdar olmak isterseniz yüksek lisans öğrencisi Psikolog Aslı Konaç ile iletişime geçebilirsiniz (E-posta: asli.konac@tedu.edu.tr).

Araştırma süresince beklemediğiniz bir stres seviyesine maruz kaldığınızı düşünüyor veya etik dışı herhangi bir uygulamayla karşılaştığınıza inanıyorsanız TED Üniversitesi İnsan Araştırmaları Etik Kurulu'na (0312 585 00 11) telefon numarasından veya iaek@tedu.edu.tr e-posta adresinden ulaşabilirsiniz.

Appendix I. Ethical Permission

Etik Kurul Onayı

TED ÜNİVERSİTESİ
İNSAN ARAŞTIRMALARI ETİK KURULU

30.11.2018

Sayı:87

Konu: Etik Kurul Kararı

Sayın

Aslı KONAÇ
Psikoloji A.B.D., Gelişim Odaklı Klinik Çocuk ve Ergen Psikolojisi Programı
Yüksek Lisans Öğrencisi

TED Üniversitesi İnsan Araştırmaları Etik Kurulunun **30.11.2018** tarih ve **2018/242** sayılı kararı ekte sunulmuştur.

Prof. Dr. Melike SAYIL
TED Üniversitesi
İnsan Araştırmaları Etik Kurul Başkanı

TED ÜNİVERSİTESİ
İNSAN ARAŞTIRMALARI ETİK KURULU

ETİK KURUL KARARLARI

Toplantı Tarihi: **30.11.2018** Toplantı Sayısı: **2018/87**

TED Üniversitesi İnsan Araştırmaları Etik Kurulu **30.11.2018** Çarşamba günü saat 13:00'te toplanarak aşağıdaki kararları almıştır.

Karar:(242) TED Üniversitesi, Gelişim Odaklı Klinik Çocuk ve Ergen Psikolojisi Yüksek Lisans Programı Öğrencisi **Aslı KONAÇ**'ın sahibi olduğu "Mükemmeliyetçilik ve Yön Bulma Strateji Arasıdaki Olası İlişki: Geç Ergenlik Dönemine Dair Çıkarımlar" başlıklı araştırma projesine ilişkin 12.11.2018-3443 tarih ve sayılı etik kurul onay talebi görüşülmüş ve proje önerisinde, araştırma kapsamında uygulanacağı beyan edilen veri toplama yöntemlerinin araştırma etiğine uygun olduğuna OYBİRLİĞİ ile karar verilmiştir.

Prof. Dr. Melike SAYIL
Başkan

Prof. Dr. Berin GÜR
Üye

Doç. Dr. Cem AKGÜNER
Üye

Dr. Öğr. Üyesi Bengi ÜNAL
Üye

Dr. Öğr. Üyesi Kürşad DEMİRUTKU
Üye

Dr. Öğr. Üyesi Tekin KÖSE
Üye

Dr. Öğr. Üyesi Aylin ÇAKIROĞLU ÇEVİK
Üye

Dr. Öğr. Üyesi Mana Ece TUNA
Üye