COMENIUS UNIVERSITY IN BRATISLAVA
FACULTY OF MATHEMATICS, PHYSICS, AND INFORMATICS

DECISION-MAKING PERFORMANCE, SATISFACTION AND STABILITY IN THE CONTEXT OF ADULT ADHD

2018 Lulu Považan, Bc

COMENIUS UNIVERSITY IN BRATISLAVA
FACULTY OF MATHEMATICS, PHYSICS, AND INFORMATICS

DECISION-MAKING PERFORMANCE, SATISFACTION AND STABILITY IN THE CONTEXT OF ADULT ADHD

Master Thesis

Study Program:	Cognitive Science
Field of Study:	Cognitive Science
Department:	FMFI.KAI - Department of Applied Informatics
Supervisor:	Mgr. Lenka Kostovičová, PhD.

Bratislava 2018 **Lulu Považan**

Declaration in lieu of oath

This is to confirm my master thesis was independently composed/authored by myself, using solely the referred sources and support.

In Bratislava, 1.6.2018

.....

Lulu Považan, Bc

Acknowledgments

I want to thank greatly to my supervisor Lenka Kostovičová for all the patience and positivity and to Toma Strle, because thanks to him this was possible to begin with.

Abstrakt

Výskumy ukazujú, že deti s ADHD majú v priebehu svojho života rôzne kognitívne ťažkosti, od hlavných príznakov deficitu pozornosti, impulzívnosti a často hyperaktivity až po komorbiditu s poruchami učenia a psychickými poruchami, ako je úzkosť alebo depresia. Tieto deti sa raz stali dospelými a problémy pretrvávajú.

Táto diplomová práca sa zaoberá rozhodovaním dospelých s ADHD, konkrétne ich intuitívnymi verzus analytickými riešeniami pri problémoch v rozhodovaní, spokojnosťou s výberom a stabilitou voľby. Ponúkame teoretické a diagnostické pozadie ADHD, neurologické koncepty ADHD a súčasný výskum o rozhodovaní u dospelých s ADHD.

V našom výskume boli účastníci vyzvaní, aby vyriešili tri páry komplexných rozhodnutí a vyriešili tri rozhodovacie problémy súvisiace s kognitívnymi odchýľkami (sebapotvrdzovanie, atribučná chyba a konjunkčná chyba). Potom hodnotili svoju spokojnosť, ochotu meniť svoj výber a subjektívny štýl rozhodovania. Porovnali sme dve vzorky účastníkov (N = 76) - všeobecná populácia a dospelí s ADHD - vyvážené podľa pohlavia, veku, vzdelania a študijneho programu a dosiahnutého vzdelania.

Predpokladali sme, že na strane dospelých s ADHD by boli rozdiely v nižšej spokojnosti a stability výberu a prevládajúcemu intuitívnemu rozhodovaniu, a teda väčšej náchylnosti na kognitívne odchýľky.

Tieto dve vzorky sa nelíšili v rozhodovacom procese - teda dospelí s ADHD neboli viac náchylní na tri kognitívne odchýľky. Napriek tomu boli neustále menej spokojní so svojimi voľbami a boli ochotnejší ich zmeniť. Avšak tieto výsledky boli významné iba v dvoch zo šiestich prípadov. To naznačuje, že rozdiely medzi všeobecnou populáciou a ľuďmi s ADHD v spokojnosti s výberom a stabilite môžu závisieť od kontextu - napríklad o tom, o čo sa rozhodujú a koľko atribútov sa hodnotí.

Naše zistenia objasňujú rozhodovanie dospelých ľudí o ADHD, nakoľko doteraz chýbali empirické dôkazy o tejto téme. Okrem základu pre ďalší výskum, naše výsledky môžu prispieť na rozšírenie vedomosti neurokognitívnych profilov ADHD.

Kľúčové slová:

ADHD Dospelých. Rozhodovanie. Neuro-Vývinová Porucha. Kognitívna Odychýľka. Spokojnosť Voľby. Stabilita Voľby.

Abstract

Research shows that children with ADHD have various cognitive difficulties through their life, from the major symptoms of attention deficits, impulsivity and often hyperactivity, to comorbidity with learning disorders and mental disorders like anxiety or depression. These children once become adults and the struggles continue.

This master thesis addresses decision-making of adults with ADHD, specifically their intuitive versus analytical solutions to decision-making problems, satisfaction with choice and choice stability. We revise the theoretical and diagnostic background of ADHD, neurological concepts of ADHD, and current research on decision making in ADHD adults. In our research, the participants were asked to make three pairs of complex choices and to solve three cognitive biases-related decision-making problems (confirmation bias, attribution error and conjunction fallacy). Afterwards, they rated their satisfaction, willingness to change their choice, and subjective decision-making style. We compared two samples of participants (N = 76) - general population and ADHD adults - balanced in gender, age, education level and study discipline.

We hypothesized that there would be differences on the side of ADHD adults, in means of lower choice satisfaction and stability, and more prevalent intuitive decision-making, therefore greater susceptibility to cognitive biases.

The two samples did not differ in decision-making performance - thus, ADHD adults were not more prone to the three cognitive biases. Yet, they were constantly less satisfied with their choices and more willing to change them. However, these results were significant only in two out of six cases. This indicates that the differences between general population and people with ADHD in choice satisfaction and stability may depend on the context - for instance, what are people deciding about and how many attributes do they evaluate.

Our findings shed light on ADHD adults' decision-making, while empirical evidence on this topic has been missing so far. Besides a base for further research, it might be beneficial for broadening the ADHD neurocognitive profiles.

Keywords:

Adult ADHD. Decision Making. Neurodevelopmental Disorder. Cognitive Bias. Choice Satisfaction. Choice Stability.

Table of Contents

Introduction

ADHD has been studied extendedly for the past decades, but needless to say, the studies focused on the effect ADHD had on diagnosed children and their behavior, and considerably not as much of the ADHD affect in adults. It might have been due to the symptoms that were recognized in children, however, are less prevalent and present themselves differently in adults, where the symptoms might rather change(in comparison with ADHD in children), but probably not disappear completely. We had to wait years for adults and their different presentation of symptoms to be included in diagnostic manuals and accommodated for practitioners to be able to recognize this disorder in older patients.

With the rise of neuroimaging techniques, it started to be apparent that the symptoms are not just behavioral but they are grounded in the brain, its structures, and pathways. More researchers from various fields got interested in this subject, as it seems that ADHD is such a complex phenomenon.

As the understanding of ADHD got better, with help of better diagnoses, thus, more people got the diagnosis of ADHD and made it possible to study it on a larger scale. It is a slow process and we believe that there is more to be found and will in upcoming years.

The aim of this thesis is to look into the subject of ADHD and decision making. We would like to introduce and gain more attention the issue of adult ADHD to more researchers, as well to the broader public. With more knowledge gain and interest on both sides, there is more will to study the subject.

In the first part, we would like to provide a theoretical background on ADHD in general, adult ADHD and mention the newest and the most significant research on adult ADHD, and ADHD and decision making. At the end of this part, we will explore the biological and neurological origins and effects of ADHD to understand its deep connections and complexity.

In the second part of this thesis, we will introduce the details of our research. The main aim was to compare subjects with ADHD symptoms (ADHD+) and subject without ADHD symptoms (ADHD-) in various decision-making tasks. Moreover, we measured their satisfaction with their choices and their stability of the choices.

1 Theoretical & Methodological Background

1.1 Attention Deficit Hyperactivity Disorder

1.1.1 Definition

Attention Deficit Hyperactivity Disorder (ADHD) is categorized as a neurodevelopmental mental disorder (Clauss-Ehlers, 2010)with problems paying attention, excessive activity, or trouble managing behavior (APA, 2013). Equally occurring manifestations are distractibility, poor impulse control, and immense motor activity (Kessler et al., 2006). Most of the cognitive and behavioral symptoms are usually united under three domains - inattention, hyperactivity, and impulsivity (APA, 2013).

ADHD develops in childhood and continuously persevere through a lifetime. The symptoms create a perpetual pattern of behaviors that are disrupting personal, social, educational, occupational and often health-related functionalities of people with the diagnosis (American Psychiatric Association, 2013; Faraone et al., 2015; Nigg, 2013).

The degree of the symptoms are problematic and therefore relevant when the extent of their severance exceeds to extreme end or/and they are not meeting age-appropriate level. The symptoms are particularly problematic as they interfere with multiple settings, such as home, school, work and causing serious issues in people's lives including relationships, education, family or employment (Kolar, 2008).

1.1.2 Prevalence

Reportedly, ADHD is the most commonly diagnosed and studied developmental disorder in children (Mattews, 2014). Currently, the percentage of children affected by the disorder is 5-10% (Akinbami, 2011) and for the adult population, the estimate is around 1–7% (Spencer, 2007).

Although, it was settled for decades that ADHD occurs exclusively in childhood, more and more data support the notion that ADHD does not decline with age, but persists throughout the whole developmental scope (Kolar, 2008). The diagnostic tools, awareness, and availability of getting diagnosed are getting better and closer to people and that reflects the increase of people diagnosed with ADHD.

In the study of Akinbami et al.(2011) is demonstrated this significant increase. In the years 1998–2000 ADHD represented 6.9% of the population in the United States, with an annual average increase for the period of 2007–2009 to 9.0% of children aged 5–17 years.
In addition, the gender variation in ADHD prevalence increased for boys from 9.9% to 12.3%, and for girls, from 3.6% to 5.5% over the same period (1998–2000 versus 2007–2009).

This might be a reflection of different ADHD presentations in genders, where girls and women tend to have an inattentive type(overly distracted and daydreaming) more often than the other types accompanied by disruptive behaviors of hyperactivity which results in reduced rates of diagnosis for the girls (Geddes et al., 2012). That leads to girls being under-diagnosed or misdiagnosed, whereas some critics might argue that boys with their hyperactive/impulsive symptoms may as well be overdiagnosed (Klostrinec and Kolin, 2012).

Although the prevalence of ADHD is similar, whether it was rated by parents, teachers or self-reports (both in children and adults)(Wilcutt, 2012), yet there can be found great differences caused by the method used(Spencer, 2007). In the United States, where DSM(for the last versions 4 and 5) criteria are adopted are demonstrably higher rates of ADHD in population (5-10% in children) (APA, 1994; APA, 2013), in contrast to countries that use ICD-10(International Classification of Diseases, 10th Revision) criteria. For example, Great Britain's estimate with ICD-10 criteria is 1%(World Health Organization, 1992). On the other hand, this disparity may originate in heterogeneity or cultural assumptions of ADHD.

1.1.3 Symptomatology of ADHD

ADHD is a multidimensional developmental disorder, it mainly spread across three symptomatic areas – inattention, hyperactivity, and impulsivity. This triad of various symptoms is the most researched and well-known as well as the most important for the diagnostic process. However, the symptoms can vary from individual to individual and the symptomatology can develop beyond the obvious ones. In addition, differences between two people can appear quantitatively as there are people who are low or high in ADHD symptoms.

Whether there are more or less of ADHD symptoms found in individuals, they can cause disruptions and deviations in diverse functionings and behaviors (Nigg, 2001; Thorell & Wahlstedt, 2006). Important matter to mention is that ADHD is a continuum where the symptoms can vary from more common, although still disruptive, to severe clinical variations of ADHD where the traits lie at the extreme end of the spectrum (Marcus & Barry, 2011). Nevertheless, even though ADHD is quite prevalent, it causes decreased quality of life and interferes with several areas of one's life, such as work, school or social contexts (Barkley, Murphy & Kwasnik, 1996). Albeit, those who are not meeting all the diagnostic criteria for ADHD can still be functionally impaired (Arcos-Burgos & Acosta, 2007; Karam, 2009).

Inattention

Attention deficits begin to be significant when an ADHD person is required to concentrate on command, most of the times on something they consider boring and repetitive, something that is not exciting for them and they become demotivated. This may lead to daydreaming or disruptive behavior (depending on their subtype, whether they are predominantly inattentive or predominantly hyperactive/impulsive), as they are about to find more interesting stimulus. Hence, the issue here might not just be the ability to concentrate but the endurance of attention (Paclt et al., 2007).

The endurance might be the problem during task performance without instant positive feedback (Jucovičová, Žáčková, 2010), or when they need to postpone the reward, for example, long-term planning, or when they should complete an incomplete task, as well as the lack of confidence in this area (Goetz, Uhlíková, 2009). Moreover, the fact that the attention fluctuates, the person fatigue rises, the will and motivation to complete the task are decreasing and therefore the chance of completing the task is on the decline too. Without completing the task there is a lesser probability of receiving positive feedback that is very important for later motivation in their life (Jucovičová, Žáčková, 2010).

The inability to hold sustained attention then interferes not only in school, to learn subjects but has a negative impact on learning social and communication skills, motor skills or practical skills (Munden, Arcelus, 2008). That altogether manifest in mental issues, unhealthy coping mechanisms, and social maladaptations, or further psychiatric disorders (Jucovičová, Žáčková, 2010; Cahová, Pejčochová, Ošlejšková, 2010).

Impulsivity

Impulsivity is defined as an immediate reaction to a stimulus when the phase of thought is absent. This means that person acts on the initial idea they have without consideration of consequences or the procedure of their actions (Jucovičová, Žáčková, 2010).

Impulsivity can be manifested by behavior as well as internalized as cognitive impulsive style and that may lead to fuzzy judgements and hurried decisions. In a life of those who are affected, it means that they cannot fully control their reactions to stimuli and signals and might not be fully aware of what they are doing (Drtílková, Šerý et al., 2007). Together with inattention, this might cause various errors (Paclt et al., 2007). In addition, as they fail to think of the outcomes that may potentially vary from negative to life-threatening, it can result in risky activities following higher chance of accidents (Paclt et al., 2007; Matějček, 2011).

The difficulty with impulsivity might challenge individuals also on a communicational level. People with ADHD have a tendency to talk very quickly, interrupt the speech of the others, change the topics often, raise their voice without their knowledge of it, and in general, having a problem to stop talking (Jucovičová, Žáčková, 2010).

Regarding the impulsive behavior, it is an indication of unequal CNS maturation, especially in children, a result of the imbalance of the arousal processes. That contributes to the lack of self-control, spontaneous and wild behaviors (Jucovičová, Žáčková, 2010).

Hyperactivity

The third key indicator of ADHD is hyperactivity. Hyperactivity is described as an excessive or developmentally disproportionate level of voice or motor activity, which is irrelevant and purposeless to the situation (Medřická et al., 2007, Svoboda et al., 2009). It exhibits itself as a need for constant movement, pointless activities, fidgeting in a way of lacking the self-control. As a result, a person with ADHD has trouble relaxing, staying calm, in peace, and inactive (Drtílková, Šerý et al., 2007).

This behaviors contradict the school setting, distract other students and disturb the teachers. For that reason, usually, ADHD first start to be apparent as an ADHD child

enters the school system. They cannot sit in their places, they move around, they are restless, they are distracted, they cannot maintain the discipline (Munden, Arcelus, 2008).

The permanent physical activity emerges from the whole body, the movements are often rapid and uncoordinated and may lead to various injuries. Overall, we can say that the person with hyperactive ADHD in a general tension, physically and mentally (Jucovičová, Žáčková, 2010). Impressively, hyperactivity causes less fatigue than expected, although when ADHD person becomes rapidly tired it may lead to irritability and aggressive responses (Paclt, 2007; Drtílková, Šerý et al., 2007). On a verbal level, the indicators are excessive and loud vocal expression, frequent comments or interruptions of others (Paclt et al., 2007).

The degree of motor activity does not match the developmental level, especially in children. In normal development, there is a progression from a tendency to respond to each stimulus immediately to learning not to respond but to postpone. This is correlated with brain maturation and thought and speech development. In children with ADHD, this process is delayed and it stays in a form of hyperactivity. That means that there is an inability to demean and differentiate responses to stimuli that constantly come to the CNS which leads to persistent stimulation. The system is then overloaded as it cannot sense the fatigue signals and be put to rest (Tresohlavá, 1986; Jucovičová, Žáčková, 2010).

However, later in adolescents and adults, the symptoms might change its nature to nausea, inability to stay in sedentary activities and discomfort during inactivity or feelings of nervousness (Drtílková, 2007).

Hypoactivity

On a contrary, some individuals might have experience with something called hypoactivity, which means lowered or restrained activity. It might appear in those who are ADHD inattentive type(type without hyperactivity issues) and it can manifest as an apathy and disinterest in activities, especially movement, sports or games. The hypoactive children appear clumsy, sparsely mobile, with cumbersome thinking, which results in them being classified as stupid or lazy (Michalova, 2007).

Other symptoms

Other symptoms that can be found in individuals with ADHD might be associated with the inadequate processing of verbal and nonverbal communication and language. This with all the other symptoms can have negative consequences on social interactions. Moreover, people with ADHD may be missing social cues and nod off during social interactions and conversations. Furthermore, delayed progression in motor development can result in poor handwriting, reoccurring together with speech and language delays (APA, 2013).

The important thing about the symptoms, especially the main ones, are a reflection of years of diagnosing children and often do not signify the symptoms of adults in full extension. In adult population of ADHD individuals, the core problems can change and manifest as various difficulties with executive function, for example, poor time management, poor organization, or memory disruptions causing failing in occupational and academic spheres (Wender et al., 2001).

On the positive side, more and more studies can be found on a connection between ADHD and creativity (Cramond, 1994; Fugate et al., 2013). Even though the attention problems and impairments are significant in ADHD, in some cases, ADHD people can have a good attention span for tasks they found interesting (Walitza et al., 2012).

1.1.4 Comorbid disorders

The life of ADHD people does not complicate just the disorder by itself, but it is determined by comorbidities, often more than one. To have ADHD as a single diagnosis, that is rare. Comorbidity can be found in 75% of ADHD adults and 65% of children with ADHD. Moreover, in 33% of those who are affected, there are two or more comorbidities are present, and the average number is three (Reimherr, F. et al., 2005; Wood et al., 1985; Reimherr, 1987).

The problems with having multiple disorder are possible difficulties with treatment, overlapping symptoms and trouble getting proper diagnoses(and risk of misdiagnosis). Although, the rates of comorbidity are relatively high, reasons why are not clear yet (Drtílková, 2007).

Most common second diagnoses and the most researched are depressive disorders and anxiety. In depression, it represents 20-50% and for anxiety, it is 40-60%

Unfortunately, people with ADHD are also more prone to have another diagnosis compared to the population without ADHD, which is another reason why these numbers are so high (Reimherr, F. et al., 2005; Wood et al., 1985; Reimherr, 1987).

In children with ADHD immense percentage appears to have various learning disabilities, around 20-30% of them manifest developmental and educational problems, including language, speech and other disorders that prevent these children to gain required skills and in some cases, they are unable to gain an education, even though their intelligence is not in question. Paradoxically, despite all the incapabilities affiliated with ADHD, ADHD is not considered learning disability. (Willcutt et al., 2010).

Frequently, ADHD people are at higher risk substance abuse, gambling or additions in general, as well as an early onset of these(usually adolescence) (Kooij et al., 2010). The reasoning behind this might be coded in ADHD brain, specifically the altered reward pathways and dopamine imbalance (Emmerik-van Oortmerssen et al., 2017). Gender might play a little effect on comorbidity. One study (Wilens et al., 2009) revealed higher rates of depression(specifically dysthymia) in men and anxiety in women from clinical patients with ADHD. More comorbidities commonly associated with ADHD diagnosis are autism disorders (10-20%), bipolar disorder (10%) and sleeping problems (80%) (Reimherr, F. et al., 2005; Wood et al., 1985; Reimherr, 1987).

1.1.5 ADHD in children

Generally, children have through their development many challenges and expectations, more difficult when they occur to have ADHD. They usually have a lot of energy, are not as organized and attentive as adults, but they develop and get used to what the society expects from them. At the same time, no child is perfect and even healthy children may have some delays, however, eventually they catch up and carry on. The other case is when they have ADHD.

The characteristics become symptoms when the degree of exhibited behavior exceeds age-appropriate level then it all sums up and creates a syndrome or disorder. Issues significantly increase as soon as the child starts to go to school. Requirements are strongly put on attention and obedience. The brain of an ADHD child is not mature enough to meet such demands (Paclt et al., 2007). Moreover, they do not have the competent social skill which may often lead to problems with teachers and classmates. ADHD children seem to be careless, loud, disobedient, moody, unsuccessful with school tasks and

tests, sometimes even aggressive. With the lack of self-control and pressure from their surrounding, they start to have low self-esteem and often develop depression or anxiety. Although, the symptoms tend to decline to some extent, it takes years and the time when the ADHD children are at school are pivotal for their development and consequentially for their later life and adulthood.
Usually, when they are early diagnosed and put to therapy or medication, the impaired areas improve. However, they can never be "cured" from ADHD, they can learn to identify their weaknesses and learn how to cope with them (Geddes et al., 2012).

On the other hand, untreated ADHD can worsen the situation for ADHD child in the period of school attendance, but has a large impact on adulthood and later life expectations and needs. They might develop comorbid disorders (like depressive and anxiety disorder), get bullied or otherwise traumatized. Any person with ADHD has a chance of adequately "normal" life when treated, everything depends on degree and severity of symptoms – about it in later chapters.

1.1.6 ADHD in adults

Formerly, ADHD as a developmental disorder, seen by many as its hyperactive presentation,was believed to be to be present in children and that its symptoms diminish with age. It was not until the late 1960s that the researchers realized that significant proportion carried the symptoms from adolescence to adulthood (Barkley 2009, Lara et al, 2009). There have been longitudinal studies that documented the persistence of impairments and related difficulties in most of the cases, reportedly 60-70% of children continue to have ADHD as adults (Biederman et al., 1995; Faraone et al., 2006). That makes it now approximately 1– 7% of the adult population (Spencer, 2007).

Acknowledging the disbalance in research on symptoms and implications of ADHD between the children and the adults, we may conclude that in children ADHD is very well known in comparison to adults where the presentations of those symptoms, the main ones – inattention, hyperactivity, and impulsivity, as well as related ones are not that well researched yet. While children may present the symptoms as various difficulties in relation to school setting or other developmental expectations for their age, in adults the symptoms manifest rather internally or more subtle expression. The adults are in a different life situation and have more responsibilities for themselves and for the others. However, the demands and stakes are higher for adults, especially for those with ADHD.

In general, they still manifest excessive talking, inability to focus the attention the proper way at the time that it is required, internal restlessness, forgetfulness, recurrently shifting from one activity to another, daydreaming or they are incapable to relax (Kooij et al., 2010). In contrast, hyperactive and impulsive symptoms decline in adulthood, inattentive symptoms persevere (Pliszka, 1998).

For many, they can have problems to achieve higher education. For once, they may encounter difficulties in school as children, due to symptoms or comorbidity with learning disabilities, and higher demands could not meet their abilities. Secondly, although they may enter into the higher education system, there their impairments might collide with high expectations they are put in. They suffer from higher rates of school transfers and academic failure (Sprich-Buckminster et al., 1993). This may be caused by their lowered capacity to finish academic tasks on their own, affected by inattention mostly, as well as to be organized and on time. That is where it can result in underachievement at school and later in the workplace. The unfortunate thing is, that such data speak about ADHD people with equal cognitive ability as their peers, oftentimes this is a problem of ADHD people with higher IQ, as this imbalance is sometimes causing more problems than it helps (Wilens et al., 2011).

After college or without the college, ADHD adults try to enter the workplace. However, they often try numbers of jobs until they find one they keep or succeed. The symptoms of ADHD influence their everyday lives and impact the job performance, resulting in being frequently late or absent, being unable to complete work tasks and making excessive errors. [41] ADHD adults have statistically higher rates of unemployment which can lead to financial problems and lower socioeconomic status (Barkley et al., 2002; Simon et al., 2013).

Boredom in the workplace and interpersonal difficulties with people at work is one of the reasons why they often choose to be self-employed or can succeed in certain kinds of jobs.

All the symptoms and related problems are connected and can further result in other areas of life. One such area is relationships, as they show to have fewer social connections, short-lived partner relationships, marital problems and higher divorce rates. This leads to the feeling of isolation, loneliness, and shame due to failures. In addition, many of ADHD people have gambling problems and problems with addiction (alcohol and substance abuse) from trying to cope with symptoms, related difficulties, or their tendency for sensation seeking behavior prone them to the higher rates of driving

accidents(impulsivity and distraction) and other accidents (Kooij et al., 2010; Sprich-Buckminster et al., 1993).

Overall, the symptoms have a large impact on their lives, one way or another, from problems in various areas to unhealthy lifestyle and poor mental health. To deal with functional impairments is not easy, however even to get the diagnosis is not the easiest as well. There is no fast or guaranteed test to do it, not yet even neurofunctional correlates to connect them to ADHD. Howbeit, we have DSM-5 criteria that were designed to help address the adults who might be affected. Unfortunately, at the moment, most of the ADHD adult population is still untreated, not to mention those who are under-diagnosed or even misdiagnosed.

1.1.7 Diagnosis of ADHD

The diagnostic process has its outcome after a chain of assessments to determine whether the person's disruptions are severe enough(and distinctive enough) to gain the diagnosis. First, they must have issues to extend that it disturbs their lives in several environments(home, school, work, etc.) and their ability to cope lowered enough that it is causing incompetence to deal with everyday life. For developmental disorders, like ADHD, the onset age have to be set, in such case, in childhood, and for it to be present the problems must have encountered for a longer period.The diagnosis can be assembled by various specialists, depending on where the problems started, or the approach of people concerned(themselves or in child's case, the parents or the teachers) and also the country and their health system evaluation the person residents in. This can vary from psychiatrists, psychologists to broader collective specialists like clinicians, pediatricians or teachers, the later stand for those in the United States, mostly (APA, 2013).

ADHD is a very heteronomous disorder that is rather a spectrum, in its own variations, not counting when occurring with comorbidities. Although, there are not two cases that would be the same, for the diagnostic purposes the characteristics of the disorder are generally the same, and are equivalent to the children, adolescents, and adults, with some variations for settings that come with age(school versus work), respectively. However, the expressions of the symptoms might change with age (APA, 2013).

DSM-5

The Diagnostic and Statistical Manual of Mental Disorders(APA, 2013), known as DSM, in its most current fifth version, is a classificational manual created by American Psychiatric Association (APA) that categorize psychiatric diagnoses, alongside with treatment proposals has a great practical importance. Their latest version was released in 2013 and has some changes to ADHD diagnostics as well. The ADHD classifiers have changed over the time, ADHD appeared in the manual in DSM-III (APA, 1980), although a certain variation of the disorder existed already in DSM-II (APA, 1968) under term Hyperkinetic Reaction of Childhood. Additionally, in the fourth version, it gained criteria for the adult population for the first time (APA, 1994).

It is set that Attention Deficit Hyperactivity Disorder (ADHD) is classified under developmental conditions usually with onset age around 12. The symptoms have to be present for at least six months and should impact two or more settings(family and home, work, school, social, leisure time, etc.). The criteria are divided into main groups of symptoms – inattentive and hyperactive/impulsive. The minimum number of symptoms from one or both criteria groups is six for the children, but for older adolescents and adults it is five. There are 18 symptoms for ADHD altogether including examples of behavior, which sometimes different for children and adults(the examples, not the symptoms), as the settings change with age, as well as the developmental expectations (APA, 2013).

The symptoms of inattention

- Very easily distracted
- Trouble maintaining attention on a task, often avoid tasks
- Keep missing details, making reckless mistakes
- Sluggish organizing and time management skills
- Problem with following instructions
- Often losing things, forgetting things
- Frequently incapable to finish tasks and assignments
- Appear not listening when others are speaking
- Problems with accuracy, processing slowly, easily confused

The symptoms of hyperactivity/impulsivity

- Frequent fidgeting with feet or hands, moving in seats
- Constant talking
- Interrupting others when they speak or in their activity
- Feeling restless or in constant motion
- Impatient, having trouble waiting
- Unable to relax or engage in quiet activities
- Problems sitting and staying seated for a longer period
- Improper commenting, showing off emotions
- Blurting out answers before questions are finished

According to the prevalence of symptoms in these groups, there are three ADHD presentations a person can fall into:

- Predominantly Inattentive presentation – prevailing symptoms of inattention, less hyperactive and impulsive symptoms – poor concentration, forgetfulness, distraction, daydreaming, disorganization
- Predominantly Hyperactive-impulsive presentation – the majority of symptoms of hyperactivity/impulsivity, less inattentive symptoms – restlessness, agitation, difficulty staying still
- Combined presentation – prevailing symptoms in both criteria groups, inattentive and hyperactive/impulsive

<u>DSM-IV vs DSM-5</u>

The DSM-IV was the first version, which included adult ADHD and first having types of presentation of the disorder. Although there were controversies surrounding these(and other) novelties, it was released in 1994, and even though the main part of 18 symptoms in unchanged, there has been enough research since then, that this version is a bit outdated for some changes in DSM-5 that even that they seem small, have recorded impact ((Barkley et al., 2005; Meijer, 2009).

The DSM-5 had two decades of research to built changes they wanted to implement upon its release in 2013. The first adjustment was lowering the number of symptoms required for late adolescence and adults from six to five (for children six symptoms persisted). Secondly, they elevated the onset age from seven to twelve as a requirement for

the first occurrence of symptoms. Then they changed “subtypes” of ADHD to “presentations” of ADHD to enable set the difference that “type” referred to something stable, but “presentation” reflects fluidness that can happen over the lifespan, with age and developmental stages, for example when combined presentation in children can transition into the predominantly inattentive presentation (Epstein & Loren, 2013).

Other changes were addition of examples of behaviors for symptoms for adults, pervasiveness is now “evidence of symptoms” instead of “evidence of impairment”, for impairment the requirement is “reduction of quality in functioning(occupational, academic or social)” and not “clinically significant” and Autism Spectrum Disorder is no longer condition for diagnostical exclusion. The last transition made was an addition of modifiers for the severity of ADHD can be quantified (from mild to moderate or severe) and the possibility to code ADHD as “in partial remission” when the full criteria are not met at the time of the diagnostic process (Epstein & Loren, 2013).

Most notably it has the biggest impact on diagnosing ADHD in the adult population and to help specialist with the identification of disorder and choosing the treatment.

ICD-10

Besides American DSM-5 there is another diagnostic tool that can be used for diagnosing people with ADHD symptoms. The criteria for International Classification of Diseases, or ICD-10 for short(tenth revision from the year 1992), were developed by World’s Health Organization (WHO) and in their version, the disorder does not carry the name ADHD but it is called Hyperkinetic Disorder (HKD). The categorization and criteria for this disorder partially different to some extent. At the moment, it more similarities with DSM-IV than DSM-5. The onset age for HKD is the age of seven and symptoms must be present for six months or more, with interference with two or more settings. ICD-10 also includes subtypes, which are namely the same as in DSM-IV, and requires 6 and more symptoms for each type (World Health Organization, 1992).

The WHO manual ICD-10 is widely used, but mostly outside of North America, especially in many European countries.

ICD vs DSM

Many points in ICD-10 and DSM-5 are rather the same, there are some differences that in the end might be the reasons why there is a significant disparity in prevalence of their disorders.

The criteria and categorization for ICD-10 are narrower, therefore the stricter rules result in lesser cases of diagnoses than in comparison to DSM-5. However, all the cases of HKD would still be identified in ADHD as it is from DSM-5, unfortunately not the other way around. Another issue is strictness regarding exclusion of comorbidities, as in ICD-10 HKD has to be a single diagnosis, thus having depression or autism would be a reason for exclusion (Taylor et al., 2004).

Both manuals have their beneficial purposes as well as weaknesses, although many European countries might use ICD-10, more and more practitioners choose to use DSM-5 for ADHD criteria with its wider interpretation, as for psychiatric disorders DSM-5 is currently most used classification (Kooij et al., 2010).

On the other hand, there is planned a release of ICD-11 this year (2018), which from initial draft seem to take classification form from DSM-5 in a case of ADHD and probably will be close to identical.

Differential diagnostics

As mentioned before, commonly ADHD is more than not associated with more disorders or related diagnosis. In that manner, it can be really difficult to separate the two(or more), where the symptoms lie, whether they overlap or one excludes the other, and the impact that they make altogether. Moreover, the severity of these multiple diagnoses might differ slightly or remarkably, which makes it even more complicated.The risks here vary from misdiagnosis or getting undiagnosed, wrong or insufficient treatments and medications, to higher stress and actually getting worse instead of getting better.

Therefore, the very important thing in the diagnostic process is the differential diagnostic. Various disorders can be found with symptoms that look like symptomatology of ADHD. Aforementioned can represent symptoms of learning disorders, mood disorders, depressive disorders, anxiety disorders and more. Even increased stress or some somatic disorders can mimic ADHD symptomatology to some extent. Precaution is very important, so in the evaluation process, appropriate diagnostic tools and approaches should be used to

minimize the risks. To consult family and friends for the diagnostics might be one of the approaches. After differential diagnostic and diagnostic process is through, finding appropriate treatment is essential (Kooij et al., 2010).

Other diagnostics – scales and measures

The diagnostic manuals mentioned before are not the only ones used in order to obtain a diagnosis. The manuals are materials that are used to develop various diagnostic tools and scales for a number of different purposes, there can be self-reporting scales, long or short versions, screening versions, interviews(structured or semi-structured) or else. These tools may also appropriate diagnostic for cultural contexts and expectations.

The approach and choice of diagnostic tool can also vary, depending on who is assessing the diagnosis, for the purpose (getting a diagnosis for treatment or research purposes), accessibility of the tools and measures and many other reasons. For example, the interviews are used for assessing diagnosis for both children and adults, whereas for children are critical evaluations from family and teachers, for adults process begins with self-report scale and may continue with an interview later (Kooij et al., 2010).

As we mentioned before, manuals are turned into tools, most common for such a purpose was DSM-IV. It lasted almost two decades, so it is not surprising that it influenced so many of them. We categorized the diagnostic tools according to DSM versions for clarity and present them below:

Diagnostic tools used for DSM IV:

DSM-IV (1994)

- Adult Rating Scale (Weyandt, 1995)
- Adult ADHD Rating Scale (Brown, 1996)
- Current ADHD Symptoms Rating Scale (Barkley & Murphy, 1998)
- Utah Criteria for adult ADHD (Wender, 1998)
- Conners' Adult ADHD Rating Scale (Conners et al., 1999)
- Conners' Adult ADHD Diagnostic Interview (Epstein et al., 1999)

DSM-IV-TR (2000)

- The Adult ADHD Self-Report Scale (ASRS) (Kessler et al., 2005)
- Adult ADHD Clinical Diagnostic Scale (ACDS) (Adler, 2014)
- The Diagnostic Interview for ADHD in Adults (DIVA) (Kooij, 2013)

The most used of them are ASRS, CAARS, and DIVA. The ASRS was created by the World Health Organization (WHO), and the Workgroup on Adult ADHD [60]. It can have eighteen symptoms checklist from the DSM-IV criteria or shorter screening version consisting of six most predictive questions, for its purpose to better represent the manifestation of ADHD in adults. The variations of CAARS scale determine occurrence and severity of ADHD. Its first version was developed in 1999 to address the ADHD symptoms in the adult population, whether ADHD impact person's life causing impairments. The DIVA questionnaire was created by Dutch researchers J.J.S. Kooij and M.H. Francken in 2007 and is the latest of these three. It contains checklist, various full examples for various settings for children and for adults, although it investigates only the presence of ADHD, not other disorders(Kooij, 2013; Harpin, 2005).

These scales were proficient in detecting ADHD adults and are periodically updated to newest versions of classification manuals, hence years of research was done in versions which correspond with older DSM-IV, sometimes the DSM-IV versions were still used after DSM-5 was released, which is a little bit unfortunate for the cases of ADHD that it might miss.

Interestingly, very latest of all is The WHO Adult ADHD Self-Report Screening Scale for DSM 5 (Ustun, 2017) which was created according to up-to-date DSM-5 requirements wich modern technology, to be precise - the Risk-Calibrated Supersparse Linear Integer Model, a machine-learning algorithm that was developed to help create screening scales. It was chosen because it was able to work out the optimal integer weights and limited numbers of screening questions. The resulting screening scale is short, enables for easier scoring, detects higher numbers of adult ADHD cases in the general population and it does so with deeper analytical insight, sensitivity to the data and specificity in the results. It's capable of differentiating well among patients presenting for special treatment and evaluation.

Conclusively, the study (Ustun, 2017) pointed that even updated DSM-IV scales underperforms compared to the DSM 5 version but is capable of detecting most of the

DSM 5 cases and do so at a threshold with a relatively low false-positive rate, though at the expense of a highly upwardly biased prevalence estimate.

Neurological diagnostic

Alongside increasing neuroimaging studies, the question arises whether it is sufficient to use neuroimaging techniques as adequate screening or diagnostic measurement. Currently, the state of these tests does not have proficient accuracy and sensitivity to determine ADHD diagnoses.

One of them is quantitative electroencephalography (QEEG) and it may or not discover about neurological and quantitative dysfunctions of ADHD if successful. Correspondingly, neuropsychological tests can be used, to mention some, for example, Stop Signal Reaction Time or CANTAB(battery) tests, and other computerized tests for evaluations of reaction time response or various executive functions, which can help us better understand the extent of limitations within the disorder (Taylor et al., 2004). Although, they seem promising and in the near future they can uncover other interesting implications about this disorder.

1.2 Neuroscience of ADHD

After years of ADHD being treated as a behavioral disorder, instead of developmental, specifically neurodevelopmental disorder it is, and technology advanced we can finally investigate the differences in ADHD brains, the amount, locations, scope of impairment in brain structures and neural pathways and its meanings, implications, and presentations on the outside. It is not an easy task, ADHD is a very heterogeneous disorder, that varies in presentation, severity, comorbidity, and is different within lifespan (children versus adults).

There has been a big boom in research including neuroimaging techniques, and in research on ADHD as well, especially the research on adult ADHD is still on a rise. Since then, there is more and more data that confirms what was previously more speculated than acknowledged – that ADHD brains are different. Interestingly, in the brain, even small change can have huge implications, and probably that is the case of an ADHD brain – a lot of smaller changes on different places make this disorder what it is and add up to its heterogeneity. The heterogeneity is at the same time one of the limitations to assess exact

difference or dysfunction for all the ADHD presentations in their diversity. Nonetheless, these findings from neuroimaging studies represent valuable insight into ADHD, for the research progress as well as a possible future of diagnosing and treatment of ADHD. (Willcutt et al. 2005; Swanson et al. 2011).

1.2.1 Brain structures in ADHD

The abnormal ADHD brain functions in brain structures are the cause of problems in ADHD in present as well as in development. The different morphology can be detected early, though not progressive. These abnormalities carry on into the adulthood, however in such case are larger for those who di not use the stimulant as a treatment (Taylor et al., 2004; Geddes et al., 2012).

The structural and functional neuroimaging studies using transcranial magnetic stimulation and electrophysiology on ADHD population showed diversity in the frontal, temporal and parietal cortical part of the brain (Taylor et al., 2004).

Differences in the prefrontal cortex and related subcortical structures might relate to concentration issues and restlessness as they are connected to behavior management and response delay (Geddes et al., 2012).Such prefrontal hypotheses for ADHD elaborate on the dorsolateral prefrontal cortex, that is affecting attention, planning, organization, and working memory, along with the orbital lesions which correlate to impulse control dysfunctions and social disinhibition (Seidman et al, 2005).

To investigate the structures of ADHD brains neuroimaging studies use the magnetic resonance or computerized tomography. Frequently, they were able to find smaller capacity in the frontal cortex, cerebellum, striatum (basal ganglia) and callosal areas (Seidman et al, 2005; Taylor et al., 2004).

Generally speaking, there are volume reductions in certain brain structures, especially proportion decrease in the left-sided anterior cortex, that can be found in children with ADHD. Moreover, the posterior parietal cortex is thinner in ADHD groups when compared to controls. The difference in brain structures of ADHD individuals are also exhibited within the prefrontal-striatal-thalamic and prefrontal-striatal-cerebellar circuits (Albrecht et al., 2015).

Further evidence stands for connection between ADHD and potential variations in structure, functions and neurotransmitter activity in a number of brain regions of ADHD

children and adults. Especially neuroimaging studies associate ADHD with structural deviations in the brain, like the following (Nakao et al., 2011; Proal et al., 2011):

- Dissimilar cortical structures
- Alterations in white matter
- Decreased grey matter density
- Lower cortical thickness (adults)
- Delayed cortical development and maturation (children)
- Compressed brain structures and total brain volume (Castellanos et al., 2002)

Various brain regions are correlated to brain network and those to diverse cognitive functions, for example, frontal regions and its effect on attention and executive functions which may imply its dysfunctions in ADHD (Makris et al., 2006).

Difference in brain activity in ADHD

Some EEG studies found elevated slow wave activity and a greater theta/beta ratio while in rest in ADHD children in comparison to control group of children (Barry et al., 2003). Regarding the ADHD adults the results are not that persistent (Koehler et al., 2009). A study from 2010 done by Buyck compared ADHD adults with a control group and found no difference in theta/beta ratio, although adults with ADHD did not show an anteriorisation of theta activity during task performance, but instead exhibited less reduced alpha 1 activity.

Their findings showed an irregularity in slow wave activity in ADHD adults while performing the task, therefore they suggest that EEG activity might become useful to discriminate between adults with and without the disorder.

Brain laterality in ADHD

One of the theories is that cognitive dysfunction in ADHD may be due to irregular brain laterality (Hale et al., 2009). Studies of behavioral research documented this atypical laterality of ADHD brain on behalf of tasks which focused on laterality including the dichotic listening task, the lexical decision task, the line bisection test and Posner's cueing task (Hale et al., 2006; Song & Hakoda, 2012; Carter et al., 1995; Hale et al., 2005).

In the context of ADHD impairments, there is a possibility that laterality abnormality can interfere with post-error processing in ADHD, or it can be caused by the combination of different laterality and impediment in the motor activation regulation (Saleh, 2016). Consequently, it can be concluded that it relates to left brain hemisphere as it is dedicated to regulating motor activation state with dopaminergic neurons (Tucker & Williamson, 1984; Declerck et al., 2004). This means that left hemisphere increases its activation particularly when it needs to keep the optimal task performance while the slower stimulus is presented. Such a function of left brain hemisphere might affect ADHD as a regulation issue of motor activation state during slower rates which thereafter causes substandard task performances like error processing. However, it is not just left hemisphere that can hold answers to cognitive impairment in ADHD, on the other side, some researchers incline to dysfunctions in right hemisphere (Hale et al., 2009b; Mohamed et al., 2015; Sandson et al., 2000).

The structural evidence in favor of ADHD brain distinctiveness is one of the first that may be successful in the determination of causes and implications of this disorder.

1.2.2 Neurotransmitter pathways and neurochemistry of ADHD

The most frequent explanation for dysfunctions in ADHD and probably one of the first ones is the imbalance of dopaminergic and noradrenergic systems which is implied to be connected to the core symptoms of ADHD (Pliszka, 1998).

Their agents are responsible for inhibitions of frontal cortical activity on subcortical structures when they are increased. The dopamine and norepinephrine pathways start in the ventral tegmental space and locus coeruleus, and from there they are lead to a number of different brain regions where they manage diverse cognitive processes.

Particularly, the pathways of dopamine and norepinephrine transmit to the prefrontal cortex and corpus striatum and are important for adjusting the executive

functions like cognitive control of behavior, as well as motor functions, reward perception and motivation (Albrecht et al., 2015). The model is supported by the fact that treatments for ADHD, the stimulants, in particular, are addressing this lack of dopamine in ADHD brains (Spencer et al., 2007).

Sometime before, the researchers hypothesized the ADHD pathophysiology stands in the raised range of dopamine transporters in ADHD brain, but later it was discovered that it is due to adaptation to stimulants. Nevertheless, psychostimulants as a treatment for ADHD are reportedly effective as they increase the activity of the neurotransmitters in aforementioned systems. Albeit, the current models address the locus coeruleus-noradrenergic system and the mesocorticolimbic dopamine pathway in their research (Albrecht et al., 2015).

Another theory comes from studies with cross-sectional and longitudinal evaluation,
and describes the effects of abnormal in fronto- subcortical pathways in ADHD. There, caudate, putamen and globus pallidus (subcortical structures) are components of neural, frontal striatal-pallidal-thalamic circuits that deal with the modulation of reward pathways, besides inhibition of behavior, executive functions, and motor control, plus they handle feedback to the cortex for the regulation of behavior (Bush et al., 2005).

Mentioned pathways employ catecholamines that carry out the stimulants from ADHD medication which are used as a treatment for this disorder, and some were able to find genetic connections to ADHD (Geddes et al., 2012). The cerebellum and corpus callosum are also connected to the pathophysiology of the disorder. The corpus callosum is connecting homotypic regions of the hemispheres and in the case of size and volume differences in the callosum and its neurons may be the reason of decreased hemispherical communication which then causes behavioral and cognitive problems in ADHD. The cerebellum's role is through cerebellar-cortical pathways (with the pons and thalamus) which reflects cognitive functions (Berquin et al., 1998; Castellanos et al., 2002).

More pathways that can be related to ADHD, or dysfunctions of these pathways, are cholinergic, glutamatergic and serotoninergic pathways (Albrecht et al., 2015).

1.2.3 Working memory in ADHD

One collective system that is impaired in ADHD is working memory. It derives from ADHD symptoms of inattention, forgetfulness, missing details, accuracy problems, slow processing (APA,1013). Working memory is one of the key components of cognitive processing and its dysfunctions have problematic implications for people with ADHD. However, working memory does have identified brain structures, some of which are affected by ADHD.

In the study done by Ko(2013) participants with and without ADHD were put under functional magnetic resonance scanning and performed phonological and visual-spatial 2-back and 3-back tasks. The aim was to examine deficits of brain activation for low-level or increased-load of working memory of ADHD adults.

The results showed that in ADHD group demonstrated the greater intensity of activation of the fronto-parietal network for working memory when compared to the controls.

When the task load increase occurred (from 2-back to 3-back tasks), ADHD participants appeared to have more difficulties.For phonological working memory, ADHD subjects exhibited greater brain activation over the left inferior frontal lobe, supplementary motor area (SMA), hippocampus and bilateral anterior cingulate.

Furthermore, they found a larger decline in brain activation over the left fronto-parietal network, in particular, dorsolateral prefrontal cortex, insula/inferior frontal lobe, supplementary motor area and precuneus in ADHD group in comparison to the control group.

In conclusion, the findings imply that ADHD adults produce more effort for low-demanding phonological working memory. However, the left fronto- parietal network brain activation is compromised when expectations for working memory surpass the capacity of ADHD adults.

1.2.4 Etiology of ADHD

Although currently ADHD is considered a disorder, from the evolution point of view, it might just be an advantage in times. High heterogeneity could play a role in reproductive fitness as complementing the gene pool diversity or being valuable for society when faster responses dangerous and unknown environments and advanced hunting skills.

However, compared to nowadays we can assume that such characteristics may be advancement or incompetency of ADHD individual depending on time and society they live in (Anney et al., 2008).

Genetics of ADHD

On the whole, it is concluded that ADHD has a high genetic disposition. The recent degree of inheritability is 0.8 and approximately 80% of the phenotypic variability is possibly grounded in genetics. Numerous research studies on twins showed mean heritability of ADHD was 75%- 90% (Geddes et al., 2012; Kessler et al., 2005; Kessler et al., 2006).Naturally, in monozygotic twins is the effect higher than in dizygotic twins, suggesting the influence of genetic factors.In the families of ADHD individuals, the parents and sibling have 2-8 times higher chance to carry ADHD as well. The predisposition to ADHD may be due to a number of various genes of small effect, which makes ADHD multifactorial condition with solid genetic foundation and probably one of the most heritable disorders (Weiss et al., 2002; Higgins & Edmund, 2013) Genetics can possibly influence whether and how much ADHD continue into adulthood.

Multiple genes are considered the role in ADHD, most of them are in some relation to dopamine, to name a few – dopamine transporters and receptor and the monoamine system (Geddes et al., 2012). For instance, genes identified in ADHD that code dopamine receptors and transporters or serotonin transport are DAT, DRD4, DRD5, DAT, DBH, TAAR1, MAOA, COMT, 5-HTT, and 5-HTR1B. More variety of genes associated with ADHD can include BDNF, SERT, SNAP25, ADRA2A, GRIN2A, and TPH2. Ordinarily, more of ADHD-related genes have to be present to affect the individual on a level that it would cause ADHD, so they are probably just a contributing factor to this complex multi-etiological disorder (Taylor et al., 2004).

1.3 Cognitive differences and decision making in ADHD

It is established that ADHD is defined by its two main domains - inattention and hyperactivity/impulsivity (APA, 2013) that have distinctive neural and cognitive attributes (Fair et al., 2013; Carr et al., 2010; Solanto et al., 2009), however, the definitive cognitive and behavioral characteristics are not well understood.

Subsequent to coping with continuous mental efforts in relation to obstacles caused by core symptoms, cognitive task performance was proposed as an aspirational measure for ADHD research (Willcutt et al., 2005; Kessler et al., 2006; Wilens et al., 2009). For such a performance the motivation and basic cognitive abilities are probably needed (Chhabildas et al., 2001; Willcutt et al., 2005; Wang et al. 2011). Unfortunately, currently, around 10–30% of unaffected subjects cannot be set apart from those affected by ADHD solely dependent on cognitive tests (Kessler et al. 2006).

From some theories and observation, people with ADHD suffer many problems like losing things (organization), forgetfulness or attention (working memory) or impulsivity (response inhibition) that are correspondent to various executive functions. (Willcutt et al. 2005; Kessler et al. 2006). A number of researchers even suggest that is, in fact, might be a subject of a subgroup of ADHD (Nigg et al., 2005).

This impairment of cognitive processes applies to children as well as for adults (Berlin et al., 2004; Biederman et al., 2004; Lambek et al., 2011; Seidman, 2006; Adler, 2010; Nigg, 2005; Balint et al., 2009). One of the core impairments might be inhibitory control deficit (Barkley, 1997; Nigg, 2001) that negatively influences further cognitive mechanisms and affects work, social or academic environments (Barkley, Murphy, & Kwasnik, 1996).

1.3.1 Executive functions

The insufficiency of executive functions, such as inhibition control, attention management or working memory can cause some symptoms of ADHD. The prevalence of ADHD people impaired with executive function in at least one task performance can be up to 80%, in comparison to those without the disorder. The issue with ADHD executive dysfunctions occurrence is that they may start to be more evident with age, maybe in adolescence or in early adulthood, which is probably caused by both increased demand for executive control and maturation of the brain. (Albrecht et al., 2015).

Executive functions are those kinds of processes that regulate the choice and monitoring of behavior that lead to the achievement of appointed goals. Therefore, the impairments in ADHD produce problems with keeping the time, maintaining concentration, ignoring distractions, remembering details, staying organized or excessive procrastination, which are eventually self-management skills that are based in the brain, for

instance, metacognition, working memory, planning, organization, self-control or flexibility (Fone & Nutt, 2005).

For the adults with ADHD, it means that the working life is impaired mainly by executive dysfunctions. However, the problems may occur in various other settings, such as personal life or leisure time activities (Sonuga-Barke et al., 2010).

Moreover, it seems that also non-executive systems are impaired in ADHD (Balint et al., 2009; Boonstra et al., 2005; Hervey, 2004; Schoechlin & Engel, 2005), as well as that the executive dysfunctions are not only characteristic to ADHD (Oosterlaan et al., 1998; Sergeant et al., 2002).

Both non-executive and executive parts of cognitive processes are distinctive, but both related to ADHD symptomatology, which can be identified especially in the motivation/emotion domain (Solanto et al., 2001; Sonuga-Barke et al., 2003; Thorell, 2007), measures on these functions can further differentiate neuropsychological subgroups(as no impairment, combination of executive and non-executive deficits, non-executive deficit only, and executive deficit only combined) (Nigg et al., 2005).

ADHD can also be connected with functional and structural brain diversity in regions correlated with executive functions (Spencer- Smith and Anderson 2009), such as anterior cingulate, basal ganglia, prefrontal cortex and motor regions (Bradshaw and Sheppard 2000).

1.3.2 Decision making

In order to understand human behavior, in general, or those affected by the disorder, we should start at the beginning, i.e. with cognitive processes and decision making.

With developmental disorder as ADHD, the impairments in attention, impulsivity and the other cognitive malfunctions linked with this disorder (Barkley, 1997) may lead to different decision-making processes and results.

With this in mind, the very beginning are the neural pathways as mentioned in the previous chapter, whether they are dopamine and norepinephrine pathways or other that relate to ADHD. There are multiple pathways as a way to understand ADHD and these pathways are often associated with executive functions, motivation, reward systems or motor functions and are key to ADHD pathology (Albrecht et al., 2015). Inspired by these pathways, models of ADHD were created.

Models of ADHD

In the past, ADHD causal models revolved more around ADHD phenotype explanation corresponding to single core symptoms and deficits (Barkley, 1997; Quay, 1997). Up to the present time, the course shifted toward multiple-pathway approach, for instance, some models feature motivational/emotional pathways (Nigg & Casey, 2005; Sagvolden et al., 2005; Sergeant, 2000; Sonuga-Barke, 2002).

One of the reasons for this advancement was research trying to explain ADHD entirely by executive dysfunctions (Barkley, 1997; Quay, 1997), however, it cannot, it explains rather the inattention than hyperactivity or impulsivity (Nigg et al., 2005; Thorell, 2007), therefore those impaired with the inattentive presentation of ADHD may be affected.

Model of ADHD: dual-pathway model

First to mention is currently very instrumental model - dual-pathway model. It is proposing a point of view where it defines variability of two pathways that lead to ADHD phenotype (Sonuga-Barke, 2002; Sonuga-Barke, 2003).

Cognitive pathway – the first of the two, affects the executive circuit. The when the executive circuit which resolves in frontal cortex (primarily in the dorsolateral prefrontal cortex) is altered the results are various executive dysfunctions.
In ADHD it can represent cognitive and behavioral dysregulation, for example, emotion dysregulation, poor behavior management or problems with planning and organizing (Sonuga-Barke, 2003).

The second – reward circuit, serves as a motivational pathway and includes the amygdala, anterior cingulate, orbitofrontal cortex and nucleus accumbens. A variation to this pathway produces a deficit in delay performance of contexts that are rich and potentially rewarding. For example, shorter delay reward gradient, in particular, a higher level of delayed reward discounting which leads the individual to try to avoid delay. Such a person then act on instantaneous decision making and prompt, often impulsive behavior to minimize an outcome of delayed results (Sonuga-Barke, 2003).

In conclusion, corresponding behaviors align with the symptoms of ADHD like the impulsivity in fast decision making, instant action to meet the stimulation manifest

hyperactivity and prioritizing irrelevant stimuli creates inattention, and can be found in children as well as in adults with ADHD (Bitsakou et al., 2009; Sonuga-Barke et al., 1992; Marx et al., 2010). This model proposes that reward proximity and valence can be influencing task performance in a way ADHD symptoms are represented (Marx et al., 2011).

Model od ADHD 2: cognitive-energetic model

The next model, the cognitive-energetic model (Sergeant, 2000), proposes that the task performance is influenced by state factors, arousal (phasic response to processing a stimulus) and activation (tonic physiological preparation to react). For this model effective cognitive function is important and that is achieved in the optimal energetic state which is described as a state of optimally adjusted arousal and activation to demands of a task. Under conditions of suboptimal adjustment(under- or overactivation) the deficits of the performance are expected. Aforementioned adjustment to the demands of the task is increasing or decreasing of activation and arousal, which are delivered by an effort pool.

The problem with ADHD is that inefficient functioning of the effort pool is happening which lead to compromised task performance as a result of energetic maladjustment.

As an effort responds to motivation, the reward should be implemented as a base for contextual factors to support the potential for task performance improvements to optimize the energetic states (Sergeant, 2005).

When applied to research (Andreou et al., 2007; Kuntsi et al., 2009) on event rate effects variability of reaction times in ADHD subjects decrease, compared to before when they showed slow and inaccurate responses when the event rate was low, similarly inaccurate when the event rate was high, just the speed of subject responses were faster (Sergeant, 2005).

In summary, based on these results, it was suggested that best performance lies at medium event rates.

Model of ADHD: dynamic developmental theory

The last, dynamic developmental theory (Sagvolden et al., 2005) resolves around different reinforcement mechanisms in people with ADHD. The model suggests that the

cause of ADHD symptoms is hypofunction of the dopaminergic system followed by deviant reinforcement of novel behavior and slower elimination of unwanted behavior. As a result of this hypofunction, individuals with ADHD cannot establish adaptive behavior in connection with assimilated behavior systems, but in contrast, they behave impulsively and in a disorganized way which all connects to the ADHD phenotype. Moreover, ADHD children demonstrate shorter time for an affiliating behavior to its consequences in comparison to children without ADHD, therefore reinforcement outside of this short time period is not effective. According to the dynamic developmental theory model, the reward should be delivered frequently and immediately so the reinforcement is effective.

For two of the models, the dual pathway model (Sonuga-Barke, 2003) and the dynamic developmental theory (Sagvolden et al., 2005), the proposition stands that the ADHD subjects' best performance is achieved when the reinforcement is applied frequently and immediately (Aase & Sagvolgen, 2006; Johnson et al., 2009; Luman et al., 2009), preferably with stronger emphasis on frequency than magnitude (Sonuga-Barke et al., 2010).

On the other side, the cognitive-energetic model suggests that inverted U-shaped function is more important than the linear, meaning that for the optimal energetic state the medium strength of contextual factors (task-associated delay, reward frequency and magnitude) is the best (Sonuga-Barke et al., 2010; Sergeant, 2000).

Despite the variation in the models, what all of the models have in common is the motivational pathway, concluding that people with ADHD can really benefit from rewarding conditions.

Risk taking in decision making

To fit the understanding of heterogeneous nature of ADHD (Sonuga-Barke & Fairchild, 2012), decision making might help us to better comprehend the consequences between motivational states and cognitive control (Castellanos et al., 2006; Steinbeis et al., 2012). In the context of decision making and ADHD coexisting together, they can result in increased risky behavior manifested from poor decision-making skills, social dysfunctions, sustaining injuries or unsafe driving (Ramos-Quiroga et al., 2013; Nijmeijer et al., 2008; Dalsgaard et al., 2015). People with ADHD also exhibit higher preferences for smaller immediate rewards in comparison to controls (Groen et al., 2013).

For such results studies research factors participating in decision making as reward (Luman et al., 2005) and modifications in cognitive control (Barkley, 1997; Pennington & Ozonoff, 1996). Most of the related research then studied the significance of motivational stimuli, described as reward-related decision-making, usually involving monetary gain. This kind of research most often focuses on temporal discounting tasks (between small immediate and large delayed rewards) and risk tasks (gambling) (Loewenstein, 2000; Zelazo & Müller, 2002).

For the decision-making tasks, the most used is a decision theory perspective (Schonberg et al., 2011). There, in the expected utility framework the anticipated value is weighted whether the risky alternative is worth by subjective counts of probability. The best and rational strategy would be constant stake on the highest sum. That way their risk adjustment is poor, although it is rational. In the expected utility perspective, the measures signify the sensitivity to risk and the rationality of the decision. The understanding and trusting the probability is reflected in the quality of the gamble. Afterwards, the subject should opt for a bet with the higher chance of winning. The magnitude of the risk that is taken by the subject demonstrating the risk taking. In the laboratory conditions, the gambling tasks where the choice lays between risky and safe options, are very popular. One of the ways to ensure risk taking is by using pricing tasks, in which the subjects are asked to invest an amount for possible participation in a gamble.

The Cambridge Gambling Test (CGT, Rogers et al., 1999) is one of those tasks where the information of exact probability is given (for example, 80% chance of token being in a red box, 20% in a blue box). This task was used in several studies to investigate aforementioned measures in ADHD population.

In a study done by (Coghill et al., 2014), ADHD group showed impairment in risk adjustment scores and quality of gamble, which was is their case compiled in one factor. Another study (Sorensen et al., 2017) found that both children, with and without ADHD bet similarly, however less steep risk adjustment was demonstrated by the ADHD subjects. ADHD children also exhibited similar risk adjustment, poorer quality of gamble and lower risk taking in a study conducted by (Kroyzer et al., 2014).

Pollak and Shoham (2015) replicated the studies with similar results, although they removed feedback after each trial and that normalized the performance of ADHD children. Whereas other studies (Drechsler et al., 2008; Ernst et al., 2003) found ADHD subjects to increase their risk taking when they retake the gambling task.

So what can be the possible explanation for such conservative and suboptimal decision making in ADHD? The authors suggest that it can be a reflection of slower learning of risks, an adoption of different response style or having problems to shift from non-strategic to strategic play.

Another dimension to think about is that the laboratory environments and real-life settings are two different conditions (Schonberg et al., 2011). To reflect on this, (Pollak et al., 2016) compared children with and without ADHD and observed them in decision-making tasks and risk-taking behaviors, in real-life conditions and in a lab. There, only in the real-life environment the differences present, not in laboratory settings, and they found no correlation between these two measures.

1.3.3 Current research on decision making in the context of adult ADHD

With the amount of research on adult ADHD, the studies investigating adult ADHD and decision making started to appear rather recently.

Ibanez et al. (2012) concentrated on affective decision-making task, using the Iowa gambling task (IGT) for it, and a rapid-decision gambling task (RDGT) in addition to a task of rational decision-making under risk (RDMUR). They were comparing adult ADHD and bi-polar disorder with controls, nevertheless, the main focus point was on impaired decision-making related to their symptomatology, where decision making may show deficits that may be associated with specific ADHD and bi-polar neurocognitive profile. As opposed to the control group, the ADHD participants showed a pattern of impaired learning by feedback (fERN) and insensitivity to reward magnitude (P3) (this ERP pattern (fERN + P3)). These patterns are associated with hyperactivity, impulsivity, working memory and executive function. This means there is a reduction of information about which decisions are the most important, consequently the decisions are impulsive and the decision strategy is not learned.

In 2012, Mäntylä et al. (2012) took adult ADHD and control group for two kinds of decision making. First, the analytic decision making was measured by the Adult Decision-Making Competence (A-DMC) battery, and the second, affective decision making, measured by the Balloon Analog Risk Task and the Iowa Gambling Task. The findings imply that the only predictor of ADHD was the applying-decision-rules task (A-DMC battery) and even medicated ADHD participants showed impairments in both types of the tasks. The researchers suggest that this means that the cognitive control of decision making

may be impaired in ADHD adults, indicating malfunction of prefrontal mediated executive functions.

Some distinction is confirmed between medicated and unmedicated individuals. In 2011 study, Stoy et al. (2011) ran "monetary incentive delay"(MID) task and found differences between treated and drug-naïve subjects with ADHD. Specifically, in the insula, more pronounced abnormal activation in reward-associated brain regions found in untreated subjects with ADHD.

Another domain examines risky decisions and reward processing. Matthies et al.'s (2012) results claim that disadvantageous choices and risky decision making are ones of the most prevalent characteristics of ADHD patients. Therefore, the authors investigated risky decision making before and after inducing boredom in both adults without and with ADHD. Negative psychosocial and health-related outcomes are both consequential to these actions and behaviors. However, the aspect of emotional states and their interrelation to the risky decision making in ADHD population, are not very well understood.

In Mowinckel et al. (2015) is said that deficient reward processing seems to be an important aspect of ADHD, though little is known about reward-based decision-making in adults with ADHD. Their article summarizes research on decision making in adult ADHD and contextualizes decision making deficits by comparing them to attention deficits. The results support the existence of deficits for adults with ADHD in areas of decision making, which are of similar magnitude as attention deficits. Those findings advice further exploration of decision making in adults with ADHD to improve the understanding of underlying neurocognitive mechanisms.

To address reward responsivity, Ernst et al. (2003) did a study where they hypothesized that decision making can be influenced by one of the characteristics of ADHD, specifically they mention the abnormalities in the area of reward responsivity and that this could interfere with the process of decision making. When they compared the ADHD with the controls, the ADHD showed a limited use of hippocampal and insular regions. However, they engage the caudal part of the right anterior cingulate more than the healthy participants.

The time dimension and related attention was the matter of Tucha et al.'s (2017) neuropsychological research on adults with ADHD. It showed deficits in various aspects of attention. Based on a complaint that the larger part of the studies did not explore the adjustment of performance over time (time-on-task effects) and therefore little is understood about continuous attention performance of ADHD adults. They tested a

hypothesis of continued attention deficits of ADHD adults with sustained attention tests, measuring selective attention, divided attention, alertness and flexibility. The performance over time deterioration (time-on-task effects) was compared between healthy individuals and patients with ADHD to conclude on sustained attention performance. Compared to healthy individuals, ADHD patients presented compelling deficits, of medium size, in divided attention and selective attention. Moreover, medium sustained attention deficits were detected in alertness measures, divided attention and selective attention. This study supports the sentiment of deficits in the sustained attention of ADHD adults.

Time is an important dimension when individuals make decisions. Although article by Wittman and Paulus (2008) do not test ADHD individuals, they take impulsive individuals(impulsivity is contemplated one of the main ADHD characteristics). Those experience time differently, that means, with a higher cost. Results show that impulsive participants, therefore, over-estimate the duration of time intervals and consequentially minimize the value of delayed rewards more firmly than do the individuals with better/higher self-control.

It seems that there are really some deficits in decision making, according to the studies in adult ADHD population. The deficits are related to the main problems that ADHD people display, as attention problems and impulsivity. The limits of the approaches in these studies are the gambling tasks and the lack of comprehensive a model of decision making in ADHD adults, that would help these studies to choose better tasks and hypothesis.

1.4 Complex choice and cognitive biases

1.4.1 Complex choice

Majority of the research done in cognitive sciences consist of a certain type of choices, otherwise, it is just analyzing some physiological reactions to something perceive. In decision making research, though, we have complex thought processes that we want to understand.

The complex choice represents such thought process and can be a valuable asset for understanding the decision making.

The complex choice means not only having more than two choices to choose from but ultimately more attributions within each choice. Those are the choices we do in our

everyday life and affects us or the others around us greatly. It is connected to choice architecture which is a process that provides a way for well-made choices through the course of minimizing negative aspects of choice and maximizing the positive outcomes (Iyengar, 2010).

There is no direct research between the complex choice and ADHD but we assumed that attention deficit and impulsivity may play a role in the task with too many attributions.

1.4.1 Choice satisfaction and choice stability

The aftermath of a complex choice task can be evaluated in choice satisfaction and choice stability, to serve as a measure of the complex choice. For the complex choice, numerous options are presented(with various attributes) which can result in satisfaction decrease (Iyengar & Lepper, 2000) and may produce negative affective reactions (Mandler, 1982). These byproducts might cause changes in the choice satisfaction and further as it decreases the confidence of the choice, also the willingness to change the previous choice (Holak & Lehmann, 1990).

It has been even suggested that choice dissatisfaction may come even in the case of objectively perfect options (Iyengar et al., 2006; Yates & Patalano, 1999).Moreover, a finding of Mather and Knight (2005) showed that positive effects of the choice might disappear when secondary task or disruption occurs. This can mean cognitive control and satisfaction probably operate distinctively, but not automatically or without the effort.

Combined with the complex choice aspect, we suggested the impulsivity might be an indicator in later regret of the choice in ADHD.

1.4.2 Cognitive biases

When the theories on cognitive biases were created they were heavily frowned upon. Theorists were trying to preserve the image of people being the rational animal and this contradicted their point of view. However, it is something that was once possibly evolutionary advantage or coping mechanism, therefore we still have it today.And certainly, being biased is not the thing we do consciously, thus we have no control of it and it can carry us into unwise decision, but most of the times it is just that our decision-

making process is not that thorough, it is not perfect and that some conditions around us can skew the decision somehow.

We did our research not with aim of understanding the heuristics of these processes, but to connect the underlying processes that may be followed by heuristics and decisions.

Confirmation bias

Confirmation bias is basically self-validation of one's personal opinion, a tendency to seek and agree with information that does not challenge individual's point of view (Baron, 2000). Take this example: students receive an assignment to write a seminal paper on the topic of paid education. The appropriate process is to find arguments for and against the topic - such a process is rational and an analytical thinking person would do it this way. However, a person inclined to utilize intuition more would be more susceptible to follow their already established ideas, for example, if they are already positioned against paid education, they will only search for information strengthening the side of the argument they believe to be correct and ignore opposing ideas and information.

In reflection to ADHD and confirmation bias is that both seem to have genetic predispositions, moreover, they both are associated with dopaminergic genes. In ADHD is causes the inattention and motivational issues and with confirmation bias, it may be affiliated with reinforcement learning (Doll et al., 2011), which as we mentioned previously in impaired in ADHD (Sagvolden et al., 2005).

Attribution error

The meaning of attribution error starts with what is one's explanation of actions of the others. Are the reasons situational or was it a personal choice, perhaps a personal characteristic of those who acted? With prevalent correlating actions with situational reasons, we want to believe in fair world and control over our lives. In such cases, we are committing the attributional error (Burger, 1981). It is then a social bias and it revolves around social interactions.

For example, it can happen, when a friend is going for an interview and they do not land the job, we have the tendency to jump to conclusion through our intuition that he or she probably did not prepare well enough, or did not make good enough impression, but

more rational based person would take into consideration also the possibility that the person did prepare well, and potentially left a good impression but that there were other candidates who had objectively more experience for example.

From symptomatic and executive functioning point of view where ADHD people, especially adults fail in social situations and estimation, more than the general public. Therefore they might be prone to commit the attributional error, in the way that it is defined Heider (1958).

Conjunction fallacy

The conjunction fallacy represents decision-making error when the assumption is that condition with more attribution is more probable than a condition with a single attribution (Tversky & Kahneman, 1983).For example, seeing a person dressed in a squared shirt with glasses, we might have the tendency to assume that this person is a science student rather than that this person is just a person because they fit our stereotypical image of a science student. The probability of single condition being met (that person being a student) is always higher than the probability of two simultaneous conditions being met (person is a student and is a science student).

As there not enough data to connect the conjunction fallacy to symptoms we assumed that the attention deficit and intuitiveness may play a role in the task.

1.4.3 Research questions and hypotheses

The aim of this thesis was to compare groups of adults with and without ADHD in choice stability, choice satisfaction and susceptibility to cognitive biases (i.e. the degree of intuitive versus deliberative decision making).

Accordingly, to the theoretical and methodological basis provided in this thesis, we are presenting these research questions and hypotheses:

Hypothesis 1: Adults with ADHD will apply rather intuitive decision-making processes (over deliberate ones) to a greater extent than non-ADHD subjects.

Hypothesis 2: Adults with ADHD will be less satisfied with their choice within complex decision making than adults without ADHD.

Hypothesis 3: Adults with ADHD will have higher tendency to change their choice than adults without ADHD.

2 METHODS

2.1 Participants

We aimed to include at least 64 participants in our experiment since we powered it to detect at least a medium-size effect (matched samples, $\alpha = .05$, $1 - \beta = .95$, two-sided non-parametric tests, additional 10%). Based on such power calculation, 150 Slovak adults participated in the study. Yet, 18 of them were excluded due to missing answers or failing to pass control items.

Next, we applied a less strict criterion for adult ADHD assessment (see chapter Materials & Measures for more details) and identified 38 people with a higher prevalence of ADHD symptoms (ADHD+) and 94 people with lower or no prevalence of ADHD symptoms (ADHD-). Subsequently, we used a simple matching technique to ensure that the two groups: ADHD+ vs ADHD- do not differ in size, and especially in important characteristics that might affect their decision-making performance. Thus, matching was done on four variables: age, gender, education, and field of study, and resulted in 38 pairs.

Our final sample consisted of 76 people: 38 ADHD+ and 38 ADHD- participants, 11 men and 27 women. Age of the participants ranged between 19 and 51 years in ADHD- group ($M = 27.2$, $SD = 7.4$) and between 19 and 53 in ADHD+ group ($M = 27.1$, $SD = 7.7$). One third of the ADHD- group ($n = 13$) finished high school, while the rest ($n = 25$) had some university degree. Almost two fifths of the ADHD+ group ($n = 15$) finished high school, while the rest ($n = 23$) had some university degree. Representation of the three study fields was identical in both groups: 32% ($n = 12$) social sciences & humanities, 55% ($n = 21$) natural & technical sciences and 13% ($n = 5$) other.

2.2 Design & Procedure

The questionnaire was in electronic version, distributed through the internet. It was shared on Facebook walls, groups (for students, artists, and Slovak adult ADHD people) and spread through personal messages.

At the very beginning, they were greeted and granted a general instruction about tasks they were about to answer/make/fill. Then they needed to do first the three the complex choice tasks(and mark down their answers), second, the cognitive biases tasks. Afterwards, they had to successfully answer what choice they made in first part(the car, the candidate, and the apartment), and decide whether they were satisfied with the choices (on the Likert scale) and whether they would choose to change their answers if given the opportunity(Likert scale). After, their self-reflection on their decision-making style – Likert scale from intuitive to analytical. Next, the 6-item DSM-5 Adult ADHD questionnaire and the last one were socio-demographic data. The order of these tasks and questions were always the same, only in the case of Speed-dating task, the options to choose from were randomized.

At the very end, we thank them for filling the questionnaire and their time, we explained that this was research on adult ADHD and we provided a mail address for their further interest on the research or questions.

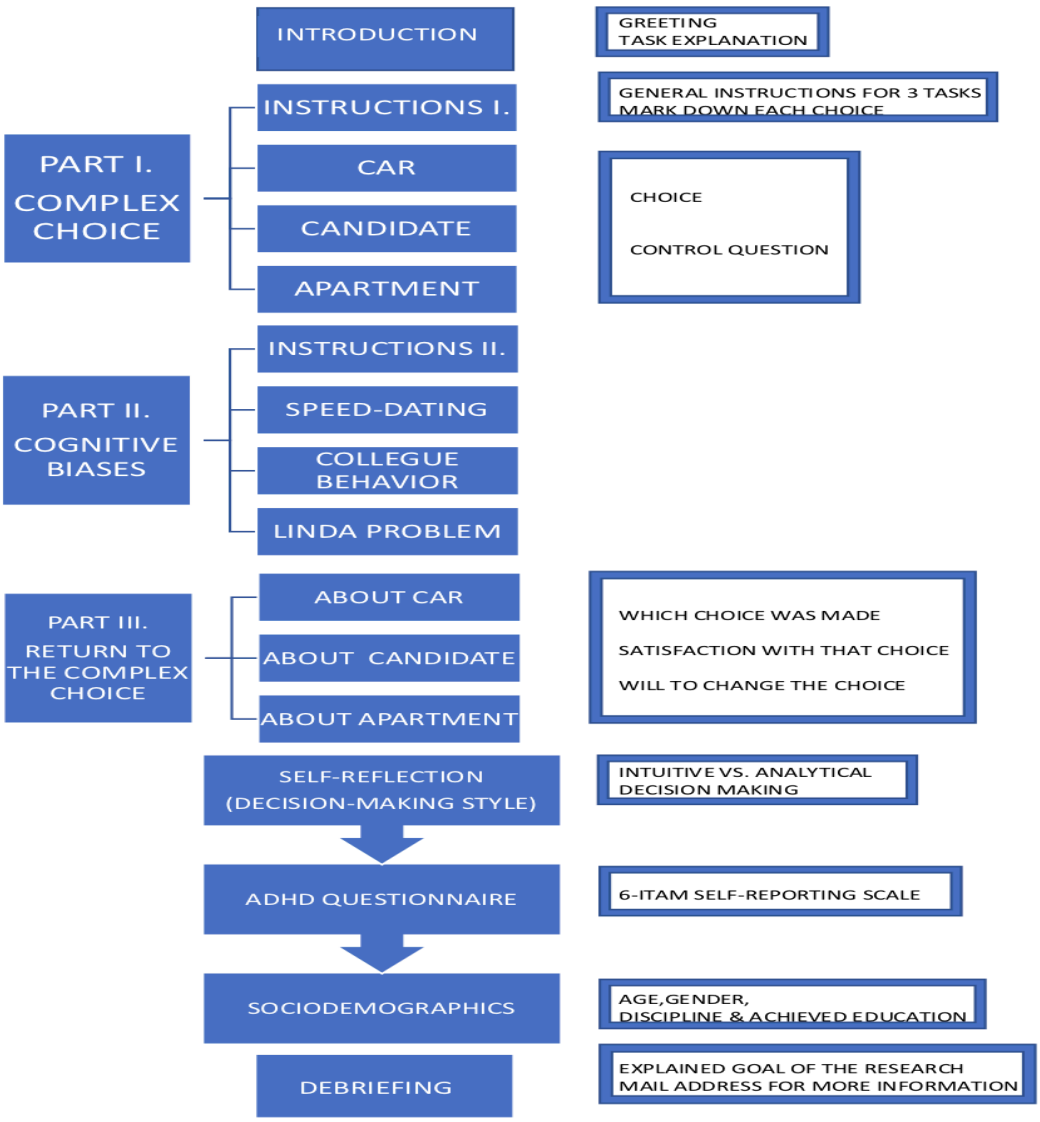

Figure 1. Flowchart of the online questionnaire

2.3 Materials & Measures

2.3.1 Complex choice

Participants were given three tasks where all the four options in each task counted as equal, to choose one best in their opinion. Later they were supposed to revisit their previous choices, grade the satisfaction on the 7-point Likert scale and decide whether they

would change their choice(also 7-point Likert scale). They regarded about/of choosing the best car and apartment for themselves, and best candidate in job application process. This choice was important for later measures, of satisfaction and stability.

	Car A	Car B	Car C	Car D
Price	Very Good (4)	Worst (2)	Best (5)	Worst (1)
Performance	Average (3)	Average (3)	Under-average (2)	Average (3)
Safety	Under-average (2)	Average (3)	Average (3)	Above average (4)
Technical condition	Average (3)	Very Good (4)	Under-average (2)	Very Good (4)

Figure 2. Car complex choice

	Candidate A	Candidate B	Candidate C	Candidate D
Communication and presentation	++	++	+++	+++
Motivation and ambition	+++	++	+++	++
References from previous employers	++	+++	++	+++
Experience in the field	+++	+	++	++
Social skills	++	+++	++	++
Success in simulated situations	+	+++	++	+++
Education & Certifications	+++	++	+	++
Appearance	++	++	+++	+

Figure 3. Candidate complex choice

	Apartment A	Apartment B	Apartment C	Apartment D
Price	+	+	-	-
Layout	-	-	+	+
Availability	+	-	+	-
Other spaces	-	+	-	+
Other aspects	-	+	+	-
Location	-	-	+	+
Monthly fees	+	+	-	-
Parking	-	-	+	+
Area	-	+	-	+
Condition	+	-	-	+
Lightness	+	-	+	-
Greenery	+	+	-	-

Figure 4. Apartment complex choice

2.3.2 Confirmation bias

First of the cognitive biases covered a speed-dating problem, where participant should decide for four questions to ask a person of interest, whereas the questions corresponded with extraversion, introversion or were neutral. Participants scores for this task were measured as [...] Ideal score (meaning no bias) is zero, where introversion nor extraversion doesn't exceed. If it does, it renders positive(introversion) or negative scores(extraversion), therefore leaning towards the bias.

2.3.3 Attribution error

Second cognitive bias task described the disturbing behavior of a potential colleague and participants were asked to write down their thoughts on reasons for such a behavior. In this case, the reasons might have been describing personal traits of the colleague or situational. These were subtracted one from another, given the absolute value in number as a score, where the ideal, again, should be zero.

2.3.4 Conjunction fallacy

The last one from cognitive biases, is a conjunction fallacy, the Linda problem in particular. We used the original, longer version, where after the description of Linda, they were given 8 statement about Linda and were asked to rate them according to the probability of Linda's professional occupation(1 for lowest probability and 8 for highest probability). Here we measured if they chose the events occurring together as more probable than a single one – Linda as a "feminist bank teller" versus "feminist" or a "bank teller". We focused on two things – whether they fail this bias and how much(subtract single event from long one).

2.3.5 Choice satisfaction and choice stability

After 6 tasks the participants needed to answer correctly on what was their choice in each of three complex choice problems (the car, the candidate, the apartment), otherwise, they would be eliminated from our research for the incorrect answers.

Both choice satisfaction and choice stability evaluated on a 7-point Likert scale, where the higher the number the higher the satisfaction and stability. On satisfaction the options varied from “I am not at all satisfied”(1 point) to “I am absolutely satisfied”(7 points). For the choice stability, we asked if they would change their choice(1 point) or stay with the original choice (7 points).

2.3.6 Self-reflection on decision-making style

At this point, the participants were asked to put a value where on a scale from “intuitive”(1 point on the Likert scale) to “analytical” (7 points on the Likert scale) they rate their decision-making style.

2.3.7 ADHD questionnaire

We used the newest version of DSM-5 self-evaluation for adult ADHD - World Health Organization Adult Attention-Deficit/Hyperactivity Disorder Self-Report Scale (Ustun, 2017). This scale was created for updated diagnostics of DSM-5, requirements that differ from the previous Adult ADHD Self-Report Scale (ASRS) (reference) that is compatible with DSM-IV criteria (reference). For example, DSM-IV required six symptoms of either inattention or hyperactivity/impulsivity, whereas DSM 5 requires only five. New screening scale is conveniently short and according to its creators, it reflects well on ADHD symptoms.

The developers used a method, the Risk-Calibrated Supersparse Linear Integer Model, a machine-learning algorithm, that was able to work out the optimal integer weights and limited numbers of screening questions. It was designed specifically to help create screening scales.

Although this scale seemed like a success compared to previous DSM-IV scales and screenings, we were not sure, how fit it would be in our environment and population. We were willing to test it, but in the conclusion, we had to simplify and lower the criteria for ADHD symptoms.

2.3.8 Sociodemogaphics

The last information we asked for were socio-demographic data. We needed them to be able to pair ADHD+ and ADHD- participants into the groups and for the statistical reasons. The items we cared about were age, gender(female, male, other), finished/completed education(basic, high school, university) and field of education/study discipline (Social sciences and Humanities, Natural sciences, Technical sciences and "other").

At the end of this questionnaire, we thank the participants, explained our research goal and provided an email address for information if they were interested.

3 RESULTS

3.1 Results I. Complex choices

I.I Cars problem

The choice frequency of each alternative is depicted in Table 1. Car B was the most preferable one in both the groups, followed by Car D.

Table 1. Complex choice 1 - Cars problem

	Car A	Car B	Car C	Car D
ADHD-	2	28	1	7
ADHD+	1	24	0	13

As for the choice satisfaction and choice stability, the comparisons are depicted in Figure 1 and Figure 2. We excluded 2 extreme outliers from the analysis of choice satisfaction, who were more than 1.5 times the interquartile range above the third quartile or below the first quartile. Similarly, we excluded 2 extreme cases from the analysis of choice stability.

Overall, participants were highly satisfied with their decisions (*Min* = 3, *Max* = 7, 45% expressed the highest possible satisfaction). ADHD- were slightly more satisfied (*Mdn* = 7, *IQR* = 1) with their choice than ADHD+ (*Mdn* = 6, *IQR* = 1). The difference was statistically insignificant yet of small effect size, $Z = -0.61$, $p = .544$, $r_m = .10$. Car choice satisfaction of participants with ADHD symptoms was slightly lower than among their counterparts.

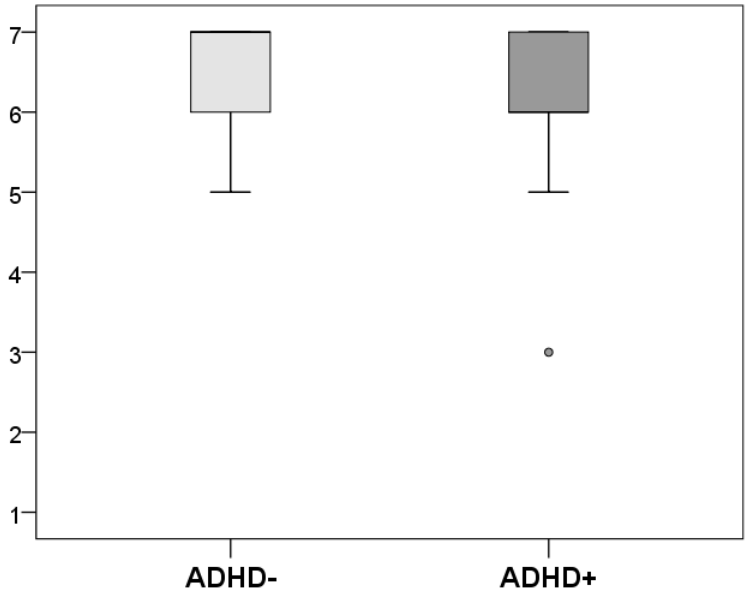

Figure 1. Choice satisfaction - Cars problem

Choice stability, in general, was also very high (*Min* = 3, *Max* = 7, 61% were sure that they do not want to change their choice). Moreover, choice stability was higher among ADHD- (*Mdn* = 7, *IQR* = 0.5) than among ADHD+ (*Mdn* = 6, *IQR* = 1). The difference was statistically significant and of medium effect size, $Z = -2.54$, $p = .011$, $r_m = .42$. Participants with ADHD symptoms were substantially more willing to change their car choice compared to their counterparts.

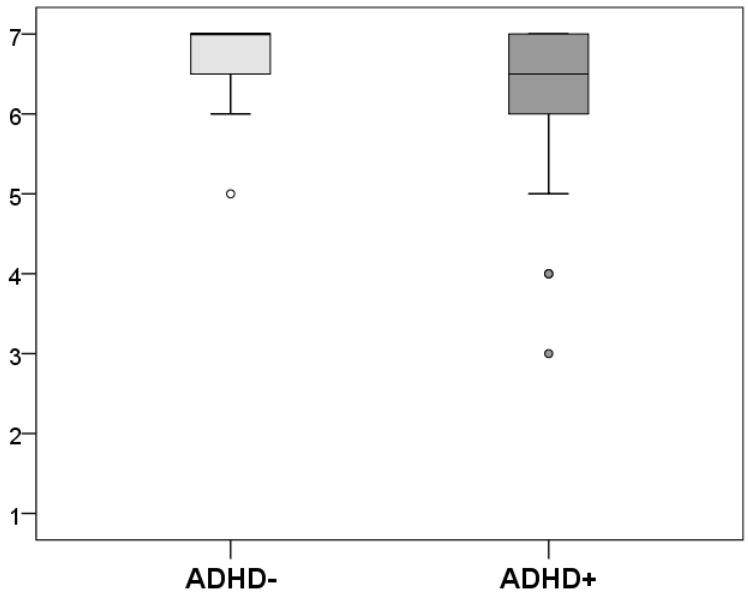

Figure 2. Choice stability - Cars problem

I.II Candidates

The choice frequency of each alternative is depicted in Table 2. Candidate C was the most preferable one in both the groups, followed by Candidate D in ADHD- group and Candidate B in ADHD+ group.

Table 2. Complex choice 2 - Candidates problem

	Candidate A	Candidate B	Candidate C	Candidate D
ADHD-	5	9	14	10
ADHD+	3	9	20	6

As for the choice satisfaction and choice stability, the comparisons are depicted in Figure 3 and Figure 4. We excluded no extreme cases from the analysis of choice satisfaction but 2 extreme outliers from the analysis of choice stability, who were more than 1.5 times the interquartile range above the third quartile or below the first quartile.

Overall, participants were highly satisfied with their decisions (*Min* = 4, *Max* = 7, 49% expressed the highest possible satisfaction). ADHD- were more satisfied (*Mdn* = 7, *IQR* = 1) with their choice than ADHD+ (*Mdn* = 6, *IQR* = 2). The difference was statistically

significant and of medium effect size, Z = -2.16, p = .031, r_m = .35. Candidate choice satisfaction of participants with ADHD symptoms was substantially lower than among their counterparts.

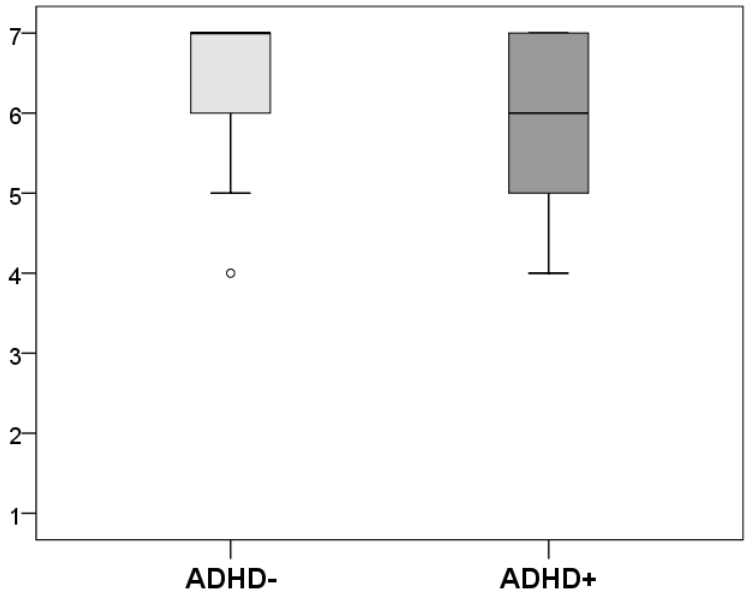

Figure 3. Choice satisfaction - Candidates problem

Choice stability, in general, was also quite high (*Min* = 2, *Max* = 7, 49% were sure that they do not want to change their choice). Moreover, choice stability was slightly higher among ADHD- (*Mdn* = 7, *IQR* = 1) than among ADHD+ (*Mdn* = 6, *IQR* = 2). The difference was statistically insignificant yet of small effect size, Z = -1.56, p = .119, r_m = .25. Participants with ADHD symptoms were slightly more willing to change their candidate choice compared to their counterparts.

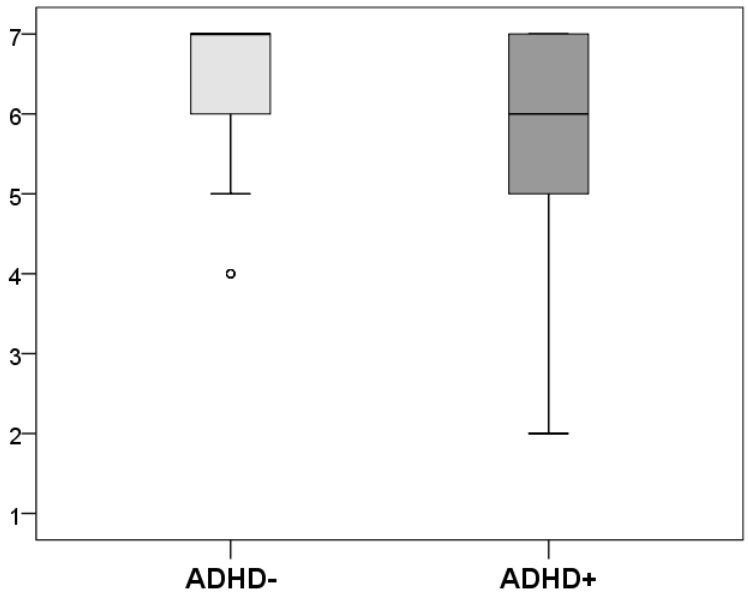

Figure 4. Choice stability - Candidates problem

I.III Apartments

The choice frequency of each alternative is depicted in Table 3. Candidate C was the most preferable one in ADHD- group, followed by Candidates A and D. Candidate A was the most preferable one in ADHD+ group, followed by Candidate C.

Table 3. Complex choice 3 - Apartments problem

	Apartment A	Apartment B	Apartment C	Apartment D
ADHD-	11	4	12	11
ADHD+	15	5	14	4

As for the choice satisfaction and choice stability, the comparisons are depicted in Figure 5 and Figure 6. There were no extreme outliers.

Overall, participants were quite satisfied with their decisions (*Min* = 2, *Max* = 7, 37% expressed the highest possible satisfaction). ADHD- (*Mdn* = 6, *IQR* = 2) and ADHD+ (*Mdn* = 6, *IQR* = 2) were similarly satisfied with their choice. The difference was statistically insignificant yet of small effect size, Z = -1.19, p = .236, r_m = .19. Apartment choice

satisfaction of participants with ADHD symptoms was slightly lower than among their counterparts (based on Mean Ranks).

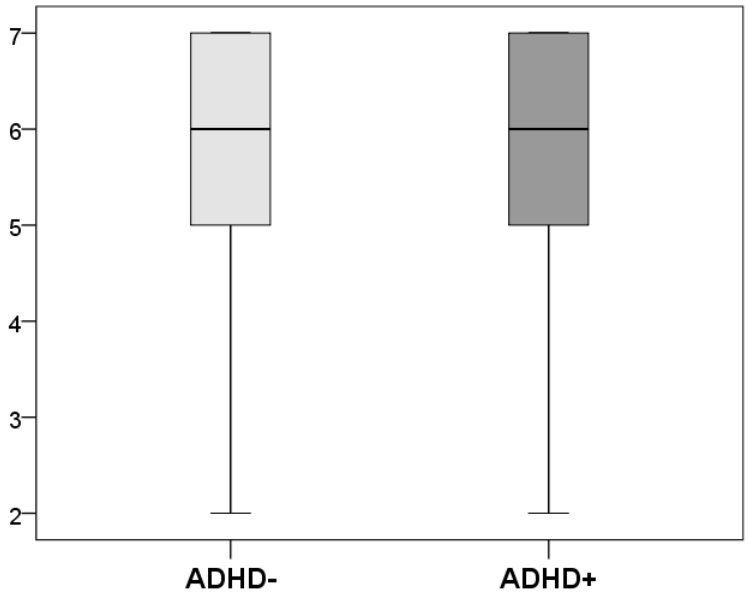

Figure 5. Choice satisfaction - Apartments problem

Choice stability, in general, was also rather high (*Min* = 1, *Max* = 7, 41% were sure that they do not want to change their choice). Moreover, choice stability was slightly higher among ADHD- (*Mdn* = 7, *IQR* = 2) than among ADHD+ (*Mdn* = 6, *IQR* = 2). The difference was statistically insignificant yet of small effect size, Z = -1.20, p = .229, r_m = .20. Participants with ADHD symptoms were slightly more willing to change their apartment choice compared to their counterparts.

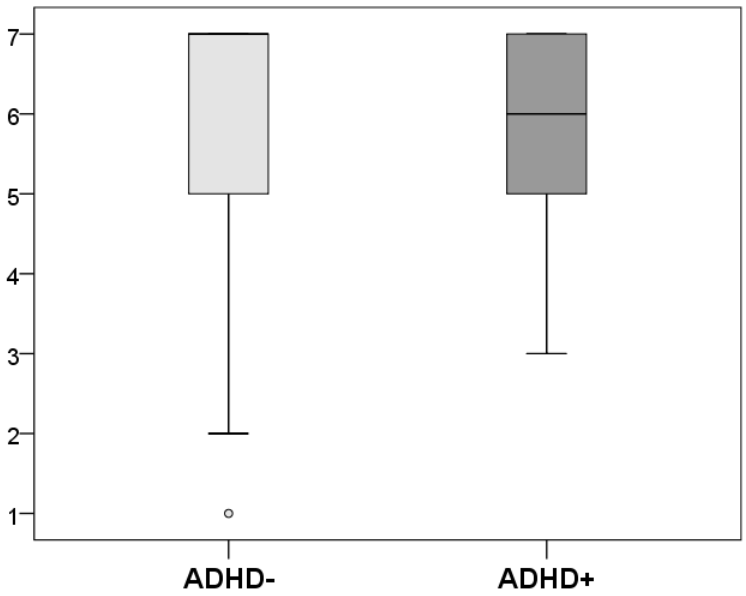

Figure 6. Choice stability - Apartments problem

I.IV Overall scores

In this final step, we calculated average scores for all the three choices. The results are depicted in Figure 7 and Figure 8. There was one extreme outlier with regard to choice stability in ADHD- group.

Overall satisfaction was slightly higher in ADHD- group (*Min* = 3.3, *Max* = 7, *Mdn* = 6.7, *IQR* = 1.3) than in ADHD+ group (*Min* = 4.3, *Max* = 7, *Mdn* = 5.8, *IQR* = 1.3). The difference was statistically insignificant yet of small effect size, $Z = -1.71$, $p = .088$, $r_m = .28$. Overall choice satisfaction of participants with ADHD symptoms was slightly lower than among their counterparts.

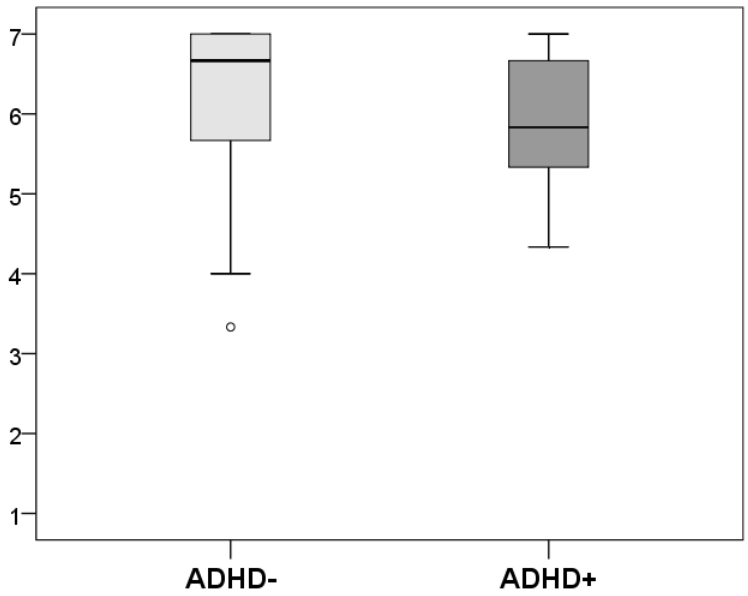

Figure 7. Choice satisfaction - Overall

Overall stability was higher in ADHD- group (*Min* = 4.3, *Max* = 7, *Mdn* = 6.7, *IQR* = 1.5) than in ADHD+ group (*Min* = 3.3, *Max* = 7, *Mdn* = 6, *IQR* = 1.3). The difference was marginally significant and of medium effect size, $Z = -1.92$, $p = .055$, $r_m = .31$. Participants with ADHD symptoms were more willing to change their choices compared to their counterparts.

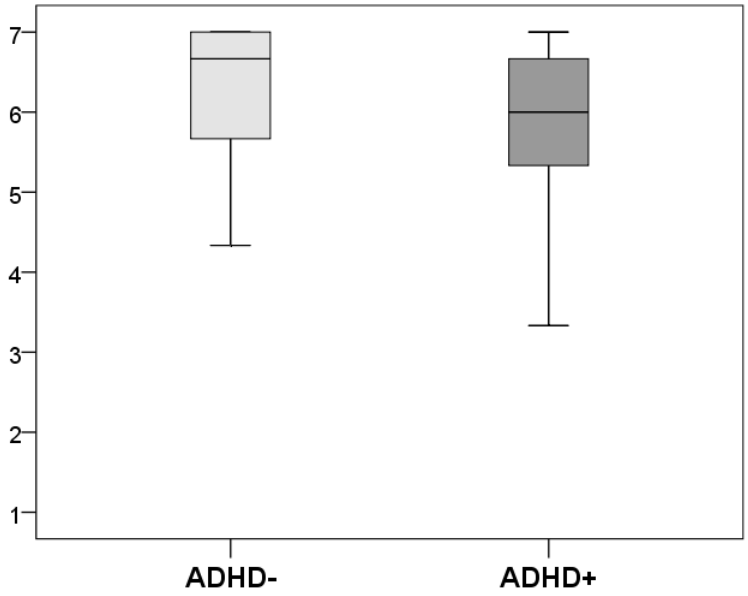

Figure 8. Choice stability - Overall

3.2 Results Intuitive vs deliberative decision-making

II.I Confirmation bias

People were choosing 4 questions out of 2 neutral items, 4 items that were in line with previous belief ("Introvert" questions) and 4 items that were against previous belief ("Extrovert" questions). Higher preference of Introvert over Extrovert questions means greater confirmation bias and more intuitive decision-making. Descriptive statistics are shown in Table 4.

Table 4. Question choices and confirmation bias score in the two groups

	EQ - Range	EQ - *M* (*SD*)	IQ - Range	IQ - *M* (*SD*)	CB - Range	CB - *M* (*SD*)
ADHD-	0 - 3	1.6 (1.1)	1 - 4	2.0 (1.0)	-2 - 4	0.4 (2.0)
ADHD+	0 - 3	1.5 (0.7)	0 - 4	2.1 (0.9)	-2 - 4	0.7 (1.5)

Note. EQ = extrovert questions, IQ = introvert questions, CB = confirmation bias score = IQ - EQ

Numbers of introvert questions, extrovert questions as well as confirmation bias scores were similar in ADHD- and ADHD+ groups. As can be seen in Table 5, there were no significant differences between the two groups either in question choices or confirmation bias score. In the case of confirmation bias problem, decisions of participants were on average rather deliberative, and neither group showed substantial tendency toward confirmation bias. Decisions of participants with ADHD symptoms were intuitive to a similar extent as decisions of their counterparts.

Table 5. Comparison of question choices and confirmation bias score

	t	*df*	*p*	*d*
EQ	0.70	37	.491	0.16
IQ	-0.63	37	.536	0.14
CB	-0.71	37	.485	0.16

Note. EQ = extrovert questions, IQ = introvert questions, CB = confirmation bias score = IQ - EQ

II.II Attribution error

People listed 4 or more reasons of hypothetical colleague´s behavior. We coded them for personality-related reasons (PR), situation-related reasons (SR) and other. Higher preference for reasons of any of the two main categories means greater attribution error and more intuitive decision-making. Descriptive statistics are shown in Table 6.

Table 6. Listed reasons and attribution error score in the two groups

	PR - Range	PR - *M* (*SD*)	SR - Range	SR - *M* (*SD*)	AE - Range	AE - *M* (*SD*)
ADHD-	0 - 5	1.7 (1.3)	0 - 5	2.9 (1.4)	0 - 5	2.3 (1.4)
ADHD+	0 - 4	1.5 (1.3)	0 - 5	3.0 (1.3)	0 - 5	2.5 (1.4)

Note. PR = personality-related reasons, SR = situation-related reasons, AE = attribution error = |PR - SR|

Numbers of personality-related reasons, situation-related reasons, as well as attribution error scores, were similar in ADHD- and ADHD+ groups. As can be seen in Table 7, there were no significant differences between the two groups either in numbers of reasons or attribution error score. In the case of attribution error problem, decisions of participants were on average rather intuitive, and both groups showed a substantial tendency toward attribution error: they preferred situational explanation over the other one. Decisions of participants with ADHD symptoms were intuitive to a similar extent as decisions of their counterparts.

Table 7. Comparison of numbers of reasons and attribution error score

	t	*df*	*p*	*d*
PR	0.56	37	.581	0.13
SR	-0.16	37	.872	0.04
AE	-0.71	37	.483	0.16

Note. PR = personality-related reasons, SR = situation-related reasons, AE = attribution error = |PR - SR|

II.III Conjunction fallacy

The more people believe that "Linda is a bank teller and is active in the feminist movement" is more probable than "Linda is a bank teller", the more they fall prey to conjunction fallacy. Hence, possible scores range from -7 to +7.

The scores ranged from -5 to 4 in ADHD- group and from -2 to 4 in ADHD+ group. As can be seen in Figure 9, the groups exhibited similar level of conjunction fallacy, $Z = -0.37$, $p = .715$, $r_m = .05$. In the case of conjunction fallacy problem, decisions of participants were on average slightly intuitive ($Mdn_{ADHD-} = 0.5$ & $Mdn_{ADHD+} = 1$), and both groups showed a small tendency toward the bias. Decisions of participants with ADHD symptoms were intuitive to a similar extent as decisions of their counterparts.

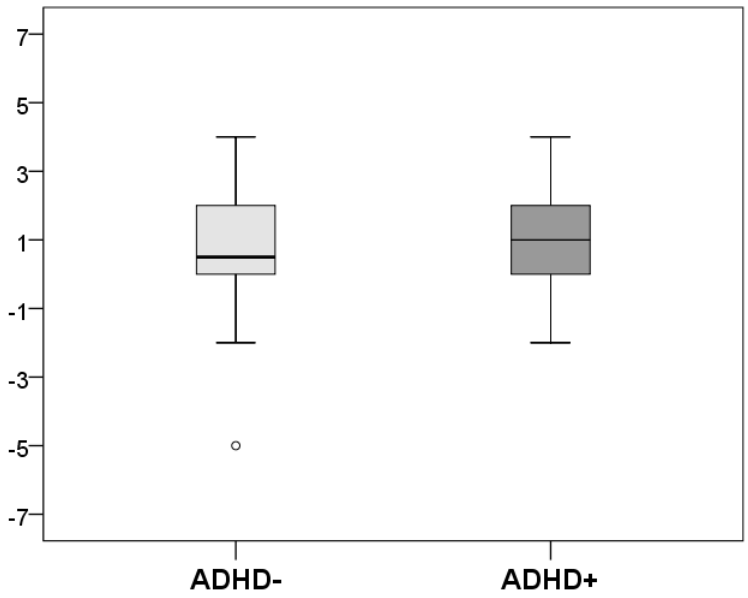

Figure 9. Conjunction fallacy

II.IV Overall performance

Next, using binary coding (0/1 = in/correct response) we calculated a decision-making score for each participant. As shown in Figure 10, ADHD- group (*Mdn* = 1, *IQR* = 0) performed in decision-making problems very similarly to ADHD+ group (*Mdn* = 1, *IQR* = 0), $Z < 0.01$, $p = .999$, $r_m < .01$.

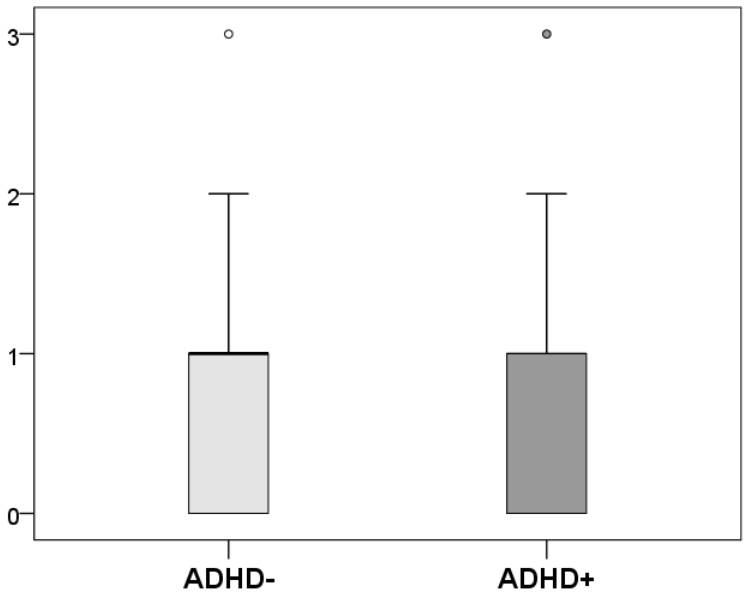

Figure 10. Decision-making performance

II.V Self-rated decision-making style

People evaluated their subjective perception of decision-making style on a 7-point Likert scale (1: intuitive, 7: deliberative). As depicted in Figure 11, members of ADHD- group (*Mdn* = 6, *IQR* = 2) perceived their decision to be more deliberative than members of ADHD+ group (*Mdn* = 5, *IQR* = 2). The difference was statistically insignificant yet of a small effect size, $Z = -1.41$, $p = .158$, $r_m = .23$.

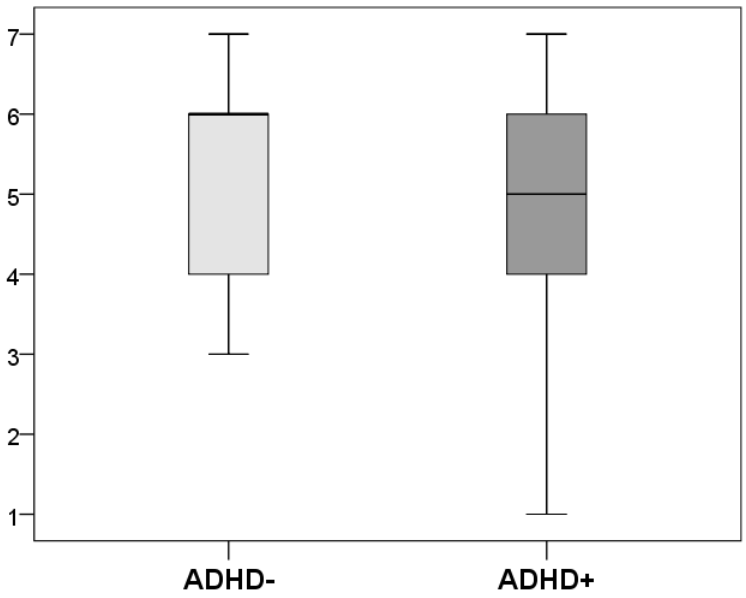

Figure 11. Decision-making style

In ADHD- group, self-rated decision-making style did not correlate with any decision-making measure (the three cognitive biases and overall decision-making performance). In ADHD+ group, self-rated decision-making style correlated positively with attribution error score, $r_S = .35$, $p = .033$. The more people with ADHD symptoms believed that their decision-making style is deliberative (and not intuitive), the worse they performed in the attribution error problem.

3.3 Summary of findings

We expected that members of the ADHD+ group would be less satisfied with their choice, more willing to change their choices, and more susceptible to cognitive biases. Our results supported the first two hypotheses, but the findings are rather inconclusive. Both choice satisfaction and choice stability were always lower in ADHD+ group, yet the choice satisfaction levels differed significantly only once (the Candidates problem), and so did the choice stability levels (the Cars problem). These patterns imply that the size of the difference between general population and people with ADHD in choice satisfaction and choice stability might depend on the context, e.g. what are people deciding about and how many alternatives and attributes are available. On the other hand, we fail to find any differences between people with ADHD and the other group in intuitive versus deliberative decision-making. Our findings suggest that there might be no substantial differences between ADHD adults and the general population in committing confirmation bias, attribution error, and conjunction fallacy.

4 Discussion

For such a prevalent condition, as ADHD is, there is still significant lack of evidence on symptoms, deficits and general functioning in ADHD adults. Even though for the past decades of research, admissible amount of research on ADHD in children for various domains can be found, the issue is that it is proved that ADHD symptoms change with age in presentation and severity (Nutt, 2007). Therefore, it was our aim to focus our research on the adult population to investigate what effect does it take on ADHD individuals as they grow older.

Variety of ADHD symptoms cause various deficits, some of those affect the executive functions, which are crucial for decision-making processes, to some degree at least.

With the rise of the cognitive sciences and their research, frequently they choose to study decision making. Sometimes they even choose ADHD as a variable, although, mostly children, adults not so much. The problem with these studies is that even when they decide to take ADHD and decision making as subjects for their study, it resolves around risky behaviors and gambling tasks. Albeit, the gambling tasks being not only popular but established indicator for some kinds of decision making, it still is a quite narrow point to study it in ADHD. That is why we tried to find a different approach and avoid gambling tasks or task that involves calculations (see the comorbid links of ADHD and learning disabilities in previous chapters).

For this reason, the aim of the thesis focused on decision making, particularly on choice satisfaction, choice stability and inclination to fall into cognitive biases in adults with ADHD.

First, they had complex choices to complete. This task was designed in a way that all of the choices were equal, but the participants needed to choose one of the options believing that one is better than the others. Consequentially, not right away, they needed to revisit this choice and reflect on it – were they satisfied or not and would they choose to change it if given the opportunity once again? There were three such tasks to give a choice. Another task was concerning three cognitive biases – confirmation bias, attribution error and conjunction fallacy(in regard to intuitiveness or deliberativeness of decision making). In the matter of participants, we tried to match them in gender, age, and education, as those might be impacts on decision making, and we wanted them to be the least different from each other as possible for the scope of this thesis.

In relation to hypotheses, there is no easy answer to that. In the first hypothesis, we suspected that ADHD+ subject will apply more intuitive decisions. In tasks focused on this, our results showed no difference. The significance was found only in ADHD+ group in regard to self-rated decision-making style correlated with attribution error score. The more they believed in their deliberativeness, the worse was their performance on the task. Were ADHD adults less satisfied with their choice – was the question related to the second hypothesis. In general, they were not, for the majority of the tasks presented, although, a significant difference was found in one of the problems – the Candidate problem. Similar results were found on choice stability – ADHD+ participant differed in the Car problem.

There were few limitations of our study. We can start with the mention of the questionnaire that was in an online form, which might have contributed to the results. This way, the conditions were not controlled, therefore for future research for similar variables we recommend supervised conditions of the controlled environment to regulate such a constraint.

Another concern was the size of the sample. For a different kind of research starting with 150 subjects can be enough, but in our case, where we took the sample from general population where the prevalence of desired ADHD people is less than 10% (Polanczyk et al., 2007), it is not enough. The best solution here would be to have a sample of ADHD people to start with and then to search for matched samples. Moreover, the subjects in both groups were not very heterogeneous or representative as they were of younger aged and generally better educated, which could be resolved in different results in decision making.

Another limit could have been on the side of the self-reporting ADHD scale. It might have been too short for the sample or culturally validated. There is a possibility that with a questionnaire consisting of more items and combined with aforementioned bigger sample size, the ADHD subject could have a stronger proportion of ADHD symptoms and the differences could have been more significant.

The other problem may be the tasks. For example, there was no difference in tasks on cognitive biases of our choosing, however, choice of some other ones might show some significant difference. In addition, one of the tasks revealed no bias at all (confirmation bias), but that was hard to predict. Although, both groups revealed to fall into attribution error extensively.

Surprisingly, both groups demonstrated high satisfaction in general, which we can credit to the hypotheticality of the choices, so it did not have the desired effect. Also, the overall score in ADHD+ was just slightly lower than the score of the control group, but in

this case, we contemplate that it may be a larger difference in a case of the bigger size of the sample. Nonetheless, the choices for the satisfaction rate should be chosen to be closer to the real-life choices than the hypothetical ones we presented.

In conclusion, we suspect that the stability and satisfaction of decision making in ADHD adults might rather be context-dependent.

There are not studies significant for us to compare the results as the parameters do not match – for age or for the methods. What we tried was to bring novelty with a hope that more studies could be inspired to choose the methods inspired to people's everyday life processes and conditions and closer to deficits specific to their condition, rather than to apply pure model-related factors to subjects with various deficits.

We believe that with the rise of neuroimaging studies and interdisciplinary research of cognitive sciences there will be more relevant and revealing findings to this matter. We also hope that our findings could be valuable to some of such studies or at least act as a proposition to those who would like to follow up in research on ADHD in regard of decision making or something else. Such a progression in research might support the development of new models of ADHD or decision making. Some future study could compare decision making of ADHD adults with ADHD children in a similar way to our research and find something new to the topic.

If the trends of ADHD will carry on, there are more to be expected to be found. The research on the issue of ADHD adults is now still in its beginning, therefore it is hard to make conclusions. However, the will and the technologies are already helping in a way to understand this subject and we hope it will continue.

Conclusion

Every few years there is a recognizable rise in the prevalence of ADHD in population, whether in children or in adults. This resolves from better diagnostics and general and public knowledge on this issue. However, there is still a lot we do not understand about ADHD – the causes or the extent of implications for people diagnosed with ADHD.

In this thesis, we focused on ADHD in the adult population, on aspects of decision making, in particular. We matched subjects with ADHD (ADHD+) and subjects without ADHD (ADHD-) in age, gender and education(degree/discipline) and compare them in intuitiveness versus deliberativeness, choice stability, and choice satisfaction.

The aim was to examine differences between these groups. Our hypotheses derived from the question whether the symptoms of ADHD can have an effect on decision-making processes and results, mainly inattention and impulsivity, which might result in more intuitive decision making, choice regret and choice instability. Although our findings support the hypotheses partially, the differences between the two groups were not so broad as the symptoms of disorder might indicate.

ADHD is from the research point a multidisciplinary issue. Therefore, cognitive sciences are perfect to pursue a research on this issue, more precisely to gain more comprehensive viewpoint on knowledge on ADHD. ADHD is not just something that can help us understand certain behaviors, but we believe that with ongoing and upcoming research on ADHD we can better understand the brain and neurodevelopment in general. And from that point of view, the biological and psychological implications of it too, even some other further.

As for the decision making, in the time that we live in, we need to understand not just the decision making of ourselves(for example, for personal well-being) but now more than ever the process behind decisions of the others as well. These have an impact not only on our everyday lives but on general society and its interests and future too.

This is a first time this kind of study was conducted in Slovakia, as there is not much of a research on adult ADHD in general. We hope this will change and local researchers will join the research already on-going on these topics abroad, moreover also to understand the state of this matter in Slovakia.

References

Aase, H., & Sagvolden, T. (2006). Infrequent, but not frequent, reinforcers produce more variable responding and deficient sustained attention in young children with attention- deficit/hyperactivity disorder (ADHD). *Journal of Child Psychology and Psychiatry*, *47*(5), 457-471.

Adler, K. (2014). Adult ADHD Self-Report Scale (ASRS-v1 . 1) Symptom Checklist. *Text*, (March), 1–3.

Adler, L. A. (2010). Monitoring adults with ADHD: a focus on executive and behavioral function. *The Journal of clinical psychiatry*, *71*(8), e18-e18.

Akinbami, L. J., Liu, X., Pastor, P. N., & Reuben, C. A. (2011). Attention deficit hyperactivity disorder among children aged 5 – 17 years in the United States, 1998– 2009. *NCHS Data Brief*, (70), 1–8.

Albrecht, B., Uebel-von Sandersleben, H., Gevensleben, H., & Rothenberger, A. (2015). Pathophysiology of ADHD and associated problems—starting points for NF interventions?. *Frontiers in human neuroscience*, *9*, 359.

American Psychiatric Association. (1968). Diagnostic and statistical manual of mental disorders. 2nd edition (DSM-II). *Washington, DC: American Psychiatric Association*.

American Psychiatric Association. (1980). Diagnostic and statistical manual of mental disorders. 3rd edition (DSM-III). *Washington, DC: American Psychiatric Association*.

American Psychiatric Association. (1994). Diagnostic and statistical manual of mental disorders.4th edition. *Washington, DC: American Psychiatric Association*.

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders. DSM 5. *Washington, DC: American Psychiatric Association*.

Andreou, P., Neale, B. M., Chen, W. A. I., Christiansen, H., Gabriels, I., Heise, A., ... & Manor, I. (2007). Reaction time performance in ADHD: improvement under fast-incentive condition and familial effects. *Psychological medicine*, *37*(12), 1703-1715.

Anney, R. J., Hawi, Z., Sheehan, K., Mulligan, A., Pinto, C., Brookes, K. J., ... & Vermeulen, S. H. (2008). Parent of origin effects in attention/deficit hyperactivity disorder (ADHD): analysis of data from the international multicenter ADHD genetics (IMAGE) program. *American Journal of Medical Genetics Part B: Neuropsychiatric Genetics*, *147*(8), 1495-1500.

Arcos-Burgos, M., & Acosta, M. T. (2007). Tuning major gene variants conditioning human behavior: the anachronism of ADHD. *Current opinion in genetics & development*, *17*(3), 234-238.

Bálint, S., Czobor, P., Komlósi, S., Meszaros, A., Simon, V., & Bitter, I. (2009). Attention deficit hyperactivity disorder (ADHD): gender-and age-related differences in neurocognition. *Psychological Medicine*, *39*(8), 1337-1345.

Barkley RA. (2009): [Advances in the diagnosis and subtyping of attention deficit hyperactivity disorder: what may lie ahead for DSM-V]. *Rev. Neurol*. 48(Suppl. 2), S101–S106.

Barkley, R. A. (1997). Behavioral inhibition, sustained attention, and executive functions: constructing a unifying theory of ADHD. *Psychological bulletin*, *121*(1), 65.

Barkley, R. A., & Murphy, K. R. (1998). *Attention-deficit hyperactivity disorder: A clinical workbook*. Guilford Press.

Barkley, R. A., Fischer, M., Smallish, L., & Fletcher, K. (2002). The persistence of attention-deficit/hyperactivity disorder into young adulthood as a function of reporting source and definition of disorder. *Journal of abnormal psychology*, *111*(2), 279.

Barkley, R. A., Murphy, K. R., O'Connell, T., & Connor, D. F. (2005). Effects of two doses of methylphenidate on simulator driving performance in adults with attention deficit hyperactivity disorder. *Journal of safety research*, *36*(2), 121-131.

Barkley, R. A., Murphy, K., & Kwasnik, D. (1996). Psychological adjustment and adaptive impairments in young adults with ADHD. *Journal of Attention Disorders*, *1*(1), 41-54.

Baron, J. (1995). Myside bias in thinking about abortion. *Thinking & Reasoning*, *1*(3), 221-235.

Barry, R. J., Clarke, A. R., & Johnstone, S. J. (2003). A review of electrophysiology in attention-deficit/hyperactivity disorder: I. Qualitative and quantitative electroencephalography. *Clinical neurophysiology*, *114*(2), 171-183.

Berlin, L., Bohlin, G., Nyberg, L., & Janols, L. O. (2004). How well do measures of inhibition and other executive functions discriminate between children with ADHD and controls?. *Child Neuropsychology*, *10*(1), 1-13.

Berquin, P. C., Giedd, J. N., Jacobsen, L. K., Hamburger, S. D., Krain, A. L., Rapoport, J. L., & Castellanos, F. X. (1998). Cerebellum in attention-deficit hyperactivity disorder A morphometric MRI study. *Neurology*, *50*(4), 1087-1093.

Biederman, J., Milberger, S., Faraone, S. V., Kiely, K., Guite, J., Mick, E., ... & Reed, E. (1995). Family-environment risk factors for attention-deficit hyperactivity disorder: A test of Rutter's indicators of adversity. *Archives of general psychiatry*, *52*(6), 464-470.

Biederman, J., Monuteaux, M. C., Doyle, A. E., Seidman, L. J., Wilens, T. E., Ferrero, F., ... & Faraone, S. V. (2004). Impact of executive function deficits and attention-deficit/hyperactivity disorder (ADHD) on academic outcomes in children. *Journal of consulting and clinical psychology*, *72*(5), 757.

Bitsakou, P., Psychogiou, L., Thompson, M., & Sonuga-Barke, E. J. (2009). Delay aversion in attention deficit/hyperactivity disorder: an empirical investigation of the broader phenotype. *Neuropsychologia*, *47*(2), 446-456.

Boonstra, A. M., Oosterlaan, J., Sergeant, J. A., & Buitelaar, J. K. (2005). Executive functioning in adult ADHD: a meta-analytic review. *Psychological medicine*, *35*(8), 1097-1108.

Brown, T. E. (1996). *Brown Attention-Deficit Disorder Scales (Brown ADD Scales): For Adolescents and Adults*. Psychological Corporation.

Burger, J. M. (1981). Motivational biases in the attribution of responsibility for an accident: A meta-analysis of the defensive-attribution hypothesis. *Psychological Bulletin*, *90*(3), 496.

Bush, G., Valera, E. M., & Seidman, L. J. (2005). Functional neuroimaging of attention-deficit/hyperactivity disorder: a review and suggested future directions. *Biological psychiatry*, *57*(11), 1273-1284.

Buyck, I., & Wiersema, R. (2010). On-and off-task EEG activity in adults with attention d eficit hyperactivity disorder. *European Child & Adolescent Psychiatry*, *19*.

Cahová, P., Pejčochová, J., Ošlejšková, H. 2010. Hyperkinetická porucha v klinické praxi dětského neurologa. In Postgraduální medicína. ISSN 1212-4184, 2010, roč. 12, č. 1, s. 8-18.

Carr, L., Henderson, J., & Nigg, J. T. (2010). Cognitive control and attentional selection in adolescents with ADHD versus ADD. *Journal of Clinical Child & Adolescent Psychology*, *39*(6), 726-740.

Carter, C. S., Krener, P., Chaderjian, M., Northcutt, C., & Wolfe, V. (1995). Asymmetrical visual-spatial attentional performance in ADHD: evidence for a right hemispheric deficit. *Biological Psychiatry*, *37*(11), 789-797.

Castellanos, F. X., Lee, P. P., Sharp, W., Jeffries, N. O., Greenstein, D. K., Clasen, L. S., ... & Zijdenbos, A. (2002). Developmental trajectories of brain volume abnormalities in children and adolescents with attention-deficit/hyperactivity disorder. *Jama*, *288*(14), 1740-1748.

Castellanos, F. X., Sonuga-Barke, E. J., Milham, M. P., & Tannock, R. (2006). Characterizing cognition in ADHD: beyond executive dysfunction. *Trends in cognitive sciences*, *10*(3), 117-123.

Clauss-Ehlers, C. S. (Ed.). (2010). *Encyclopedia of cross-cultural school psychology*. Springer Science & Business Media.

Coghill, D. R., Seth, S., & Matthews, K. (2014). A comprehensive assessment of memory, delay aversion, timing, inhibition, decision making and variability in attention deficit hyperactivity disorder: advancing beyond the three-pathway models. *Psychological medicine*, *44*(9), 1989-2001.

Conners, C. K., Erhardt, D., & Sparrow, E. P. (1999). Conners' adult ADHD rating scales (CAARS): technical manual. North Tonawanda: MHS.

Cramond, B. (1994). Attention-Deficit Hyperactivity Disorder and Creativity—What is the connection?. *The Journal of Creative Behavior*, *28*(3), 193-210.

Dalsgaard, S., Leckman, J. F., Mortensen, P. B., Nielsen, H. S., & Simonsen, M. (2015). Effect of drugs on the risk of injuries in children with attention deficit hyperactivity disorder: a prospective cohort study. *The Lancet Psychiatry*, *2*(8), 702-709.

Declerck, C., De Brabander, B., & Boone, C. (2004). Asymmetries in activation and arousal may contribute to lateralised effects of habituation and contingency learning during a repetitive choice reaction time task. *Laterality: Asymmetries of Body, Brain and Cognition*, *9*(4), 359-380.

Doll, B. B., Hutchison, K. E., & Frank, M. J. (2011). Dopaminergic genes predict individual differences in susceptibility to confirmation bias. *Journal of Neuroscience*, *31*(16), 6188-6198.

Drechsler, R., Rizzo, P., & Steinhausen, H. C. (2008). Decision-making on an explicit risk-taking task in preadolescents with attention-deficit/hyperactivity disorder. *Journal of Neural Transmission*, *115*(2), 201-209.

Drtílková, I. 2007. Hyperaktivní dítě : Vše, co potřebujete vědět odítěti s hyperkinetickou poruchou (ADHD). Druhé vydání. Praha : Galén, 2007. 87 s. ISBN 978-80-7262-447-8.

Drtílková, I., Šerý, O. et al. 2007. *Hyperkinetická porucha / ADHD*. První vydání. Praha : Galén, 2007. 268 s. ISBN 978-80-7262-419-5.

Emmerik-van Oortmerssen, K., Glind, G., Koeter, M. W., Allsop, S., Auriacombe, M., Barta, C., ... & Casas, M. (2014). Psychiatric comorbidity in treatment-seeking substance use disorder patients with and without attention deficit hyperactivity disorder: results of the IASP study. *Addiction*, *109*(2), 262-272.

Epstein, J. N., & Loren, R. E. (2013). Changes in the definition of ADHD in DSM-5: subtle but important. *Neuropsychiatry*, *3*(5), 455.

Epstein, J. N., Johnson, D. E., Conners, C. K., & Conners Adult, A. D. H. D. (1999). Diagnostic Interview for DSM-IV (CAADID). *Multi Health Systems Inc., New York*.

Ernst, M., Grant, S. J., London, E. D., Contoreggi, C. S., Kimes, A. S., & Spurgeon, L. (2003). Decision making in adolescents with behavior disorders and adults with substance abuse. *American Journal of Psychiatry*, *160*(1), 33-40.

Ernst, M., Kimes, A. S., London, E. D., Matochik, J. A., Eldreth, D., Tata, S., ... & Bolla, K. (2003). Neural substrates of decision making in adults with attention deficit hyperactivity disorder. *American Journal of Psychiatry*, *160*(6), 1061-1070.

Fair, D., Nigg, J. T., Iyer, S., Bathula, D., Mills, K. L., Dosenbach, N. U., ... & Buitelaar, J. K. (2013). Distinct neural signatures detected for ADHD subtypes after controlling for micro-movements in resting state functional connectivity MRI data. *Frontiers in systems neuroscience*, *6*, 80.

Faraone, S. V., Biederman, J., & Mick, E. (2006). The age-dependent decline of attention deficit hyperactivity disorder: A meta-analysis of follow-up studies. *Psychological Medicine*, 36(02), 159–165.

Fone, K. C., & Nutt, D. J. (2005). Stimulants: use and abuse in the treatment of attention deficit hyperactivity disorder. *Current opinion in pharmacology*, *5*(1), 87-93.

Fugate, C. M., Zentall, S. S., & Gentry, M. (2013). Creativity and working memory in gifted students with and without characteristics of attention deficit hyperactive disorder: Lifting the mask. *Gifted Child Quarterly*, *57*(4), 234-246.

Geddes et al., 2012. *Psychiatry*. ISBN 978-0-19-923396-0 (4th ed.) p. 446-450.

Goetz, M., Uhlíková, P. 2009. ADHD : Porucha pozornosti s hyperaktivitou. První vydání. Praha : Galén, 2009. 160 s. ISBN 978-80-7262-630-4.

Groen, Y., Gaastra, G. F., Lewis-Evans, B., & Tucha, O. (2013). Risky behavior in gambling tasks in individuals with ADHD–a systematic literature review. *PLoS One*, *8*(9), e74909.

Hale, T. S., Loo, S. K., Zaidel, E., Hanada, G., Macion, J., & Smalley, S. L. (2009b). Rethinking a right hemisphere deficit in ADHD. *Journal of attention disorders*, *13*(1), 3-17.

Hale, T. S., McCracken, J. T., McGough, J. J., Smalley, S. L., Phillips, J. M., & Zaidel, E. (2005). Impaired linguistic processing and atypical brain laterality in adults with ADHD. *Clinical neuroscience research*, *5*(5-6), 255-263.

Hale, T. S., Smalley, S. L., Hanada, G., Macion, J., McCracken, J. T., McGough, J. J., & Loo, S. K. (2009). Atypical alpha asymmetry in adults with ADHD. *Neuropsychologia*, *47*(10), 2082-2088.

Hale, T. S., Zaidel, E., McGough, J. J., Phillips, J. M., & McCracken, J. T. (2006). Atypical brain laterality in adults with ADHD during dichotic listening for emotional intonation and words. *Neuropsychologia*, *44*(6), 896-904.

Harpin, V. A. (2005). The effect of ADHD on the life of an individual, their family, and community from preschool to adult life. *Archives of disease in childhood*, *90*(suppl 1), i2-i7.

Heider, F. (1958). *The psychology of interpersonal relations*. New York: John Wiley & Sons.

Hervey, A. S., Epstein, J. N., & Curry, J. F. (2004). Neuropsychology of adults with attention-deficit/hyperactivity disorder: a meta-analytic review. *Neuropsychology*, *18*(3), 485.

Higgins, E. S., & George, M. S. (2013). *Neuroscience of clinical psychiatry: the pathophysiology of behavior and mental illness*. Lippincott Williams & Wilkins.

Holak, S. L., & Lehmann, D. R. (1990). Purchase intentions and the dimensions of innovation: An exploratory model. *Journal of Product Innovation Management*, *7*(1), 59-73.

Chhabildas, N., Pennington, B. F., & Willcutt, E. G. (2001). A comparison of the neuropsychological profiles of the DSM-IV subtypes of ADHD. *Journal of abnormal child psychology*, *29*(6), 529-540.

Ibanez, A., Cetkovich, M., Petroni, A., Urquina, H., Baez, S., Gonzalez-Gadea, M. L., ... & Teitelbaum, J. (2012). The neural basis of decision-making and reward processing in adults with euthymic bipolar disorder or attention-deficit/hyperactivity disorder (ADHD). *PloS one*, *7*(5), e37306.

Iyengar, S. S., Wells, R. E., & Schwartz, B. (2006). Doing better but feeling worse: Looking for the "best" job undermines satisfaction. *Psychological Science*, *17*(2), 143-150.

Johnson, K. A., Wiersema, J. R., & Kuntsi, J. (2009). What would Karl Popper say? Are current psychological theories of ADHD falsifiable?. *Behavioral and Brain Functions*, *5*(1), 15.

Jucovičová, D., Žáčková, H. 2010. *Neklidné a nesoustředěné dítě ve škole a v rodině*. Vydání 1. Praha : Grada, 2010. 208 s. ISBN 978-80-247-2697-7.

Karam, R. G., Bau, C. H., Salgado, C. A., Kalil, K. L., Victor, M. M., Sousa, N. O., ... & Belmonte-de-Abreu, P. (2009). Late-onset ADHD in adults: milder, but still dysfunctional. *Journal of Psychiatric Research*, *43*(7), 697-701.

Kessler, R. C., Adler, L., Ames, M., Barkley, R. A., Birnbaum, H., Greenberg, P., ... & Üstün, T. B. (2005). The prevalence and effects of adult attention deficit/hyperactivity disorder on work performance in a nationally representative sample of workers. *Journal of Occupational and Environmental Medicine*, *47*(6), 565-572.

Kessler, R. C., Adler, L., Ames, M., Demler, O., Faraone, S., Hiripi, E. V. A., ... & Ustun, T. B. (2005b). The World Health Organization Adult ADHD Self-Report Scale (ASRS): a short screening scale for use in the general population. *Psychological medicine*, *35*(2), 245-256.

Kessler, R. C., Adler, L., Barkley, R., Biederman, J., Conners, C. K., Demler, O., ... & Spencer, T. (2006). The prevalence and correlates of adult ADHD in the United States: results from the National Comorbidity Survey Replication. *American Journal of psychiatry*, *163*(4), 716-723.

Ko, C. H., Yen, J. Y., Yen, C. F., Chen, C. S., Lin, W. C., Wang, P. W., & Liu, G. C. (2013). Brain activation deficit in increased-load working memory tasks among

adults with ADHD using fMRI. *European archives of psychiatry and clinical neuroscience*, *263*(7), 561-573.

Koehler, S., Lauer, P., Schreppel, T., Jacob, C., Heine, M., Boreatti-Hümmer, A., ... & Herrmann, M. J. (2009). Increased EEG power density in alpha and theta bands in adult ADHD patients. *Journal of neural transmission*, *116*(1), 97-104.

Kolar, D., Keller, A., Golfinopoulos, M., Cumyn, L., Syer, C., & Hechtman, L. (2008). Treatment of adults with attention-deficit/hyperactivity disorder. *Neuropsychiatric disease and treatment*, *4*(2), 389.

Kooij, J. S. (2013). *Adult ADHD: Diagnostic assessment and treatment*. Springer Science & Business Media.

Kooij, S. J., Bejerot, S., Blackwell, A., Caci, H., Casas-Brugué, M., Carpentier, P. J., ... & Gaillac, V. (2010). European consensus statement on diagnosis and treatment of adult ADHD: The European Network Adult ADHD. *BMC psychiatry*, *10*(1), 67.

Kroyzer, N., Gross-Tsur, V., & Pollak, Y. (2014). Risk taking in adolescents with attention deficit hyperactivity disorder on a probabilistic choice task. *The Journal of nervous and mental disease*, *202*(3), 247-252.

Kuntsi, J., Wood, A. C., Van Der Meere, J., & Asherson, P. (2009). Why cognitive performance in ADHD may not reveal true potential: findings from a large population- based sample. *Journal of the International Neuropsychological Society*, *15*(4), 570- 579.

Lambek, R., Tannock, R., Dalsgaard, S., Trillingsgaard, A., Damm, D., & Thomsen, P. H. (2011). Executive dysfunction in school-age children with ADHD. *Journal of attention disorders*, *15*(8), 646-655.

Lara C, Fayyad J, de Graaf R et al. (2009): Childhood predictors of adult attentiondeficit/hyperactivity disorder: results from the World Health Organization World Mental Health Survey Initiative. *Biol.Psychiatry* 65(1), 46–54.

Loewenstein, G. (2000). Emotions in economic theory and economic behavior. *American economic review*, *90*(2), 426-432.

Luman, M., Oosterlaan, J., & Sergeant, J. A. (2005). The impact of reinforcement contingencies on AD/HD: a review and theoretical appraisal. *Clinical psychology review*, *25*(2), 183-213.

Luman, M., Van Noesel, S. J., Papanikolau, A., Van Oostenbruggen-Scheffer, J., Veugelers, D., Sergeant, J. A., & Oosterlaan, J. (2009). Inhibition, reinforcement sensitivity and temporal information processing in ADHD and ADHD+ ODD: evidence of a separate entity?. *Journal of abnormal child psychology*, *37*(8), 1123-1135.

Makris, N., Biederman, J., Valera, E. M., Bush, G., Kaiser, J., Kennedy, D. N., ... & Seidman, L. J. (2006). Cortical thinning of the attention and executive function networks in adults with attention-deficit/hyperactivity disorder. *Cerebral Cortex*, *17*(6), 1364- 1375.

Mandler, G. (1982). The structure of value: Accounting for taste. *Center for Human Information Processing Report*, *101*.

Marcus, D. K., & Barry, T. D. (2011). Does attention-deficit/hyperactivity disorder have a dimensional latent structure? A taxometric analysis. *Journal of abnormal psychology*, *120*(2), 427.

Marx, I., Hübner, T., Herpertz, S. C., Berger, C., Reuter, E., Kircher, T., ... & Konrad, K. (2010). Cross-sectional evaluation of cognitive functioning in children, adolescents and young adults with ADHD. *Journal of neural transmission*, *117*(3), 403-419.

Marx, I., Pieper, J., Berger, C., Häßler, F., & Herpertz, S. C. (2011). Contextual influence of highly valued rewards and penalties on delay decisions in children with ADHD. *Journal of behavior therapy and experimental psychiatry*, *42*(4), 488-496.

Matějček, Z. 2011. Praxe dětského psychologického poradenství. Vyd. 2. Praha : Portál, 2011. 344 s. ISBN 978-80-262-0000-0.

Matthews, M., Nigg, J. T., & Fair, D. A. (2014). Attention deficit hyperactivity disorder. *Current Topics in Behavioral Neurosciences*, *16*, 235–66.

Matthies, S., Philipsen, A., & Svaldi, J. (2012). Risky decision making in adults with ADHD. *Journal of behavior therapy and experimental psychiatry*, *43*(3), 938-946.

Mäntylä, T., Still, J., Gullberg, S., & Del Missier, F. (2012). Decision making in adults with ADHD. *Journal of attention disorders*, *16*(2), 164-173.

Medrická, H., Kunčíková, M., Novák, V. ADHD. *Neurologie pro praxi*. ISSN 1212-0543, 2007, roč. 8, č. 4, s 219-221.

Meijer, W. M., Faber, A., van den Ban, E., & Tobi, H. (2009). Current issues around the pharmacotherapy of ADHD in children and adults. *Pharmacy world & science*, *31*(5), 509-516.

Michalová, Z. 2007. Sonda do problematiky specifických poruch chování. Havlíčkuv Brod : Tobiáš, 2007. 199 s. ISBN 80-7311-075-X

Mohamed, S. M., Börger, N. A., Geuze, R. H., & Van Der Meere, J. J. (2015). Brain lateralization and self-reported symptoms of ADHD in a population sample of adults: a dimensional approach. *Frontiers in psychology*, *6*, 1418.

Mohamed, S. M., Börger, N. A., Geuze, R. H., & van der Meere, J. J. (2016). Post-error adjustments and ADHD symptoms in adults: The effect of laterality and state regulation. *Brain and cognition*, *108*, 11-19.

Mowinckel, A. M., Pedersen, M. L., Eilertsen, E., & Biele, G. (2015). A meta-analysis of decision-making and attention in adults with ADHD. *Journal of Attention Disorders*, *19*(5), 355-367.

Munden, A., Arcelus, J. 2008. *Poruchy pozornosti ahyperaktivita : Přehled současných poznatků a přístupů pro rodiče a odborníky*. Vyd. 3. Praha : Portál, 2008. 120 s. ISBN 978-80-7367-430-4.

Nakao, T., Radua, J., Rubia, K., & Mataix-Cols, D. (2011). Gray matter volume abnormalities in ADHD: voxel-based meta-analysis exploring the effects of age and stimulant medication. *American Journal of Psychiatry*, *168*(11), 1154-1163.

Nigg, J. T. (2001). Is ADHD a disinhibitory disorder?. *Psychological bulletin*, *127*(5), 571.

Nigg, J. T. (2005). Neuropsychologic theory and findings in attention-deficit/hyperactivity disorder: the state of the field and salient challenges for the coming decade. *Biological psychiatry*, *57*(11), 1424-1435.

Nigg, J. T., & Casey, B. J. (2005). An integrative theory of attention-deficit/hyperactivity disorder based on the cognitive and affective neurosciences. *Development and psychopathology*, *17*(3), 785-806.

Nigg, J. T., Willcutt, E. G., Doyle, A. E., & Sonuga-Barke, E. J. (2005). Causal heterogeneity in attention-deficit/hyperactivity disorder: do we need neuropsychologically impaired subtypes?. *Biological psychiatry*, *57*(11), 1224-1230.

Nijmeijer, J. S., Minderaa, R. B., Buitelaar, J. K., Mulligan, A., Hartman, C. A., & Hoekstra, P. J. (2008). Attention-deficit/hyperactivity disorder and social dysfunctioning. *Clinical psychology review*, *28*(4), 692-708.

Nutt, D. J., Fone, K., Asherson, P., Bramble, D., Hill, P., Matthews, K., ... & Weiss, M. (2007). Evidence-based guidelines for management of attention-deficit/hyperactivity disorder in adolescents in transition to adult services and in adults: recommendations from the British Association for Psychopharmacology. *Journal of Psychopharmacology*, *21*(1), 10-41.

Oosterlaan, J., Logan, G. D., & Sergeant, J. A. (1998). Response inhibition in AD/HD, CD, comorbid AD/HD+ CD, anxious, and control children: A meta-analysis of studies

with the stop task. *The Journal of Child Psychology and Psychiatry and Allied Disciplines*, *39*(3), 411-425.

Paclt, I. (2007). *Hyperkinetická porucha a poruchy chování* (No. s 234). Grada.

Pennington, B. F., & Ozonoff, S. (1996). Executive functions and developmental psychopathology. *Journal of child psychology and psychiatry*, *37*(1), 51-87.

Pliszka, S. R. (1998). Comorbidity of attention-deficit/hyperactivity disorder with psychiatric disorder: an overview. *The Journal of clinical psychiatry*, *59*, 50-58.

Polanczyk, G., De Lima, M. S., Horta, B. L., Biederman, J., & Rohde, L. A. (2007). The worldwide prevalence of ADHD: a systematic review and metaregression analysis. *American journal of psychiatry*.

Pollak, Y., & Shoham, R. (2015). Feedback may harm: Role of feedback in probabilistic decision making of adolescents with ADHD. *Journal of abnormal child psychology*, *43*(7), 1233-1242.

Pollak, Y., Shalit, R., & Aran, A. (2018). Risk taking and adult attention deficit/hyperactivity disorder: A gap between real life behavior and experimental decision making. *Psychiatry research*, *259*, 56-62.

Proal, E., Reiss, P. T., Klein, R. G., Mannuzza, S., Gotimer, K., Ramos-Olazagasti, M. A., ... & Milham, M. P. (2011). Brain gray matter deficits at 33-year follow-up in adults with attention-deficit/hyperactivity disorder established in childhood. *Archives of general psychiatry*, *68*(11), 1122-1134.

Quay, H. C. (1997). Inhibition and attention deficit hyperactivity disorder. *Journal of abnormal child psychology*, *25*(1), 7-13.

Ramos-Quiroga, J. A., Montoya, A., Kutzelnigg, A., Deberdt, W., & Sobanski, E. (2013). Attention deficit hyperactivity disorder in the European adult population:

prevalence, disease awareness, and treatment guidelines. *Current medical research and opinion*, *29*(9), 1093-1104.

Reimherr, F. W., Marchant, B. K., Strong, R. E., Hedges, D. W., Adler, L., Spencer, T. J., ... & Soni, P. (2005). Emotional dysregulation in adult ADHD and response to atomoxetine. *Biological psychiatry*, *58*(2), 125-131.

Reimherr, F. W., Wender, P. H., Wood, D. R., & Ward, M. (1987). An open trial of {l}-tyrosine in the treatment of attention deficit disorder, residual type. *The American journal of psychiatry*.

Rogers, R. D., Everitt, B. J., Baldacchino, A., Blackshaw, A. J., Swainson, R., Wynne, K., ... & London, M. (1999). Dissociable deficits in the decision-making cognition of chronic amphetamine abusers, opiate abusers, patients with focal damage to prefrontal cortex, and tryptophan-depleted normal volunteers: evidence for monoaminergic mechanisms. *Neuropsychopharmacology*, *20*(4), 322.

Sagvolden, T., Johansen, E. B., Aase, H., & Russell, V. A. (2005). A dynamic developmental theory of attention-deficit/hyperactivity disorder (ADHD) predominantly hyperactive/impulsive and combined subtypes. *Behavioral and Brain Sciences*, *28*(3), 397-418.

Sagvolden, T., Johansen, E. B., Aase, H., & Russell, V. A. (2005). A dynamic developmental theory of attention-deficit/hyperactivity disorder (ADHD) predominantly hyperactive/impulsive and combined subtypes. *Behavioral and Brain Sciences*, *28*(3), 397-418.

Sandson, T. A., Bachna, K. J., & Morin, M. D. (2000). Right hemisphere dysfunction in ADHD: Visual hemispatial inattention and clinical subtype. *Journal of Learning Disabilities*, *33*(1), 83-90.

Seidman, L. J. (2006). Neuropsychological functioning in people with ADHD across the lifespan. *Clinical psychology review*, *26*(4), 466-485.

Seidman, L. J., Valera, E. M., & Makris, N. (2005). Structural brain imaging of attention-deficit/hyperactivity disorder. *Biological psychiatry*, *57*(11), 1263-1272.

Sergeant, J. (2000). The cognitive-energetic model: an empirical approach to attention-deficit hyperactivity disorder. *Neuroscience & Biobehavioral Reviews*, *24*(1), 7-12.

Sergeant, J. A. (2005). Modeling attention-deficit/hyperactivity disorder: a critical appraisal of the cognitive-energetic model. *Biological psychiatry*, *57*(11), 1248-1255.

Sergeant, J. A., Geurts, H., & Oosterlaan, J. (2002). How specific is a deficit of executive functioning for attention-deficit/hyperactivity disorder?. *Behavioural brain research*, *130*(1-2), 3-28.

Sheena Iyengar (2010). *The Art of Choosing*. Twelve. pp. 208–213. ISBN 0-446-50410-6

Schoechlin, C., & Engel, R. R. (2005). Neuropsychological performance in adult attention-deficit hyperactivity disorder: Meta-analysis of empirical data. *Archives of Clinical Neuropsychology*, *20*(6), 727-744.

Schonberg, T., Fox, C. R., & Poldrack, R. A. (2011). Mind the gap: bridging economic and naturalistic risk-taking with cognitive neuroscience. *Trends in cognitive sciences*, *15*(1), 11-19.

Simon, V., Czobor, P., & Bitter, I. (2013). Is ADHD severity in adults associated with the lifetime prevalence of comorbid depressive episodes and anxiety disorders?. *European Psychiatry*, *28*(5), 308-314.

Solanto, M. V., Abikoff, H., Sonuga-Barke, E., Schachar, R., Logan, G. D., Wigal, T., ... & Turkel, E. (2001). The ecological validity of delay aversion and response inhibition as measures of impulsivity in AD/HD: a supplement to the NIMH multimodal treatment study of AD/HD. *Journal of abnormal child psychology*, *29*(3), 215-228.

Solanto, M. V., Schulz, K. P., Fan, J., Tang, C. Y., & Newcorn, J. H. (2009). Event-Related fMRI of Inhibitory Control in the Predominantly Inattentive and Combined Subtypes of ADHD. *Journal of Neuroimaging*, *19*(3), 205-212.

Song, Y., & Hakoda, Y. (2012). The interference of local over global information processing in children with attention deficit hyperactivity disorder of the inattentive type. *Brain and Development*, *34*(4), 308-317.

Sonuga-Barke, E. J. (2002). Psychological heterogeneity in AD/HD—a dual pathway model of behaviour and cognition. *Behavioural brain research*, *130*(1-2), 29-36.

Sonuga-Barke, E. J. (2003). The dual pathway model of AD/HD: an elaboration of neuro-developmental characteristics. *Neuroscience & Biobehavioral Reviews*, *27*(7), 593-604.

Sonuga-Barke, E. J., & Fairchild, G. (2012). Neuroeconomics of attention-deficit/hyperactivity disorder: differential influences of medial, dorsal, and ventral prefrontal brain networks on suboptimal decision making?. *Biological Psychiatry*, *72*(2), 126-133.

Sonuga-Barke, E. J., Dalen, L., & Remington, B. (2003). Do executive deficits and delay aversion make independent contributions to preschool attention-deficit/hyperactivity disorder symptoms?. *Journal of the American Academy of Child & Adolescent Psychiatry*, *42*(11), 1335-1342.

Sonuga-Barke, E. J., Wiersema, J. R., van der Meere, J. J., & Roeyers, H. (2010). Context-dependent dynamic processes in attention deficit/hyperactivity disorder: differentiating common and unique effects of state regulation deficits and delay aversion. *Neuropsychology review*, *20*(1), 86-102.

Sonuga-Barke, E. J. S., Taylor, E., Sembi, S., & Smith, J. (1992). Hyperactivity and delay aversion—I. The effect of delay on choice. *Journal of Child Psychology and Psychiatry*, *33*(2), 387-398.

Sørensen, L., Sonuga-Barke, E., Eichele, H., van Wageningen, H., Wollschlaeger, D., & Plessen, K. J. (2017). Suboptimal decision making by children with ADHD in the face of risk: Poor risk adjustment and delay aversion rather than general proneness to taking risks. *Neuropsychology*, *31*(2), 119.

Spencer, T. J., Biederman, J., & Mick, E. (2007). Attention-deficit/hyperactivity disorder: diagnosis, lifespan, comorbidities, and neurobiology. *Journal of pediatric psychology*, *32*(6), 631-642.

Sprich-Buckminster, S., Biederman, J., Milberger, S., Faraone, S. V., & Lehman, B. K. (1993). Are perinatal complications relevant to the manifestation of ADD? Issues of comorbidity and familiality. *Journal of the American Academy of Child & Adolescent Psychiatry*, *32*(5), 1032-1037.

Steinbeis, N., Bernhardt, B. C., & Singer, T. (2012). Impulse control and underlying functions of the left DLPFC mediate age-related and age-independent individual differences in strategic social behavior. *Neuron*, *73*(5), 1040-1051.

Stoy, M., Schlagenhauf, F., Schlochtermeier, L., Wrase, J., Knutson, B., Lehmkuhl, U., ... & Ströhle, A. (2011). Reward processing in male adults with childhood ADHD—a comparison between drug-naive and methylphenidate-treated subjects. *Psychopharmacology*, *215*(3), 467-481.

Svoboda, M., Krejčírová, D., Vágnerová, M. *Psychodiagnostika dětí a dospívajících*. Praha: Portál, 2009. 89 s. ISBN: 9788073675660

Swanson, J., Baler, R. D., & Volkow, N. D. (2011). Understanding the effects of stimulant medications on cognition in individuals with attention-deficit hyperactivity disorder: a decade of progress. *Neuropsychopharmacology*, *36*(1), 207.

Taylor, E., Döpfner, M., Sergeant, J., Asherson, P., Banaschewski, T., Buitelaar, J., ... & Steinhausen, H. C. (2004). European clinical guidelines for hyperkinetic disorder–first upgrade. *European child & adolescent psychiatry*, *13*(1), i7-i30.

Thorell, L. B. (2007). Do delay aversion and executive function deficits make distinct contributions to the functional impact of ADHD symptoms? A study of early academic skill deficits. *Journal of Child Psychology and Psychiatry*, *48*(11), 1061-1070.

Thorell, L. B., & Wåhlstedt, C. (2006). Executive functioning deficits in relation to symptoms of ADHD and/or ODD in preschool children. *Infant and Child Development*, *15*(5), 503-518.

Třesohlavá, Z. *Lehká mozková dysfunkce v dětském věku*. Praha: Avicentum, 1986. ISBN 08-047-86.

Tucker, D. M., & Williamson, P. A. (1984). Asymmetric neural control systems in human self-regulation. *Psychological review*, *91*(2), 185.

Tucha, L., Fuermaier, A. B., Koerts, J., Buggenthin, R., Aschenbrenner, S., Weisbrod, M., ... & Tucha, O. (2017). Sustained attention in adult ADHD: Time-on-task effects of various measures of attention. *Journal of Neural Transmission*, *124*(1), 39-53.

Tversky, A., & Kahneman, D. (1983). Extensional versus intuitive reasoning: The conjunction fallacy in probability judgment. *Psychological review*, *90*(4), 293.

Ustun, B., Adler, L. A., Rudin, C., Faraone, S. V., Spencer, T. J., Berglund, P., … Kessler, R. C. (2017). The world health organization adult attention-deficit/hyperactivity disorder self-report screening scale for DSM-5. *JAMA Psychiatry,* 74(5), 520–526.

Walitza, S., Drechsler, R., & Ball, J. (2012). Das schulkind mit ADHS. *Therapeutische Umschau*, *69*(8), 467.

Wang, L. J., Huang, Y. S., Chiang, Y. L., Hsiao, C. C., Shang, Z. Y., & Chen, C. K. (2011). Clinical symptoms and performance on the continuous performance test in children with attention deficit hyperactivity disorder between subtypes: a natural follow-up study for 6 months. *BMC psychiatry*, *11*(1), 65.

Weiss, M., Murray, C., & Weiss, G. (2002). Adults with attention-deficit/hyperactivity disorder: current concepts. *Journal of Psychiatric Practice®*, *8*(2), 99-111.

Wender, P. H. (1998). Attention-deficit hyperactivity disorder in adults. *Psychiatric Clinics*, *21*(4), 761-774.

Weyandt, L. L., Linterman, I., & Rice, J. A. (1995). Reported prevalence of attentional difficulties in a general sample of college students. *Journal of Psychopathology and Behavioral Assessment*, *17*(3), 293–304.

Wilens, T. E., Biederman, J., Faraone, S. V., Martelon, M., Westerberg, D., & Spencer, T. J. (2009). Presenting ADHD symptoms, subtypes, and comorbid disorders in clinically referred adults with ADHD. *The Journal of clinical psychiatry*, *70*(11), 1557.

Wilens, T. E., Morrison, N. R., & Prince, J. (2011). An update on the pharmacotherapy of attention-deficit/hyperactivity disorder in adults. *Expert review of neurotherapeutics*, *11*(10), 1443-1465.

Willcutt, E. G., Betjemann, R. S., McGrath, L. M., Chhabildas, N. A., Olson, R. K., DeFries, J. C., & Pennington, B. F. (2010). Etiology and neuropsychology of comorbidity between RD and ADHD: The case for multiple-deficit models. *Cortex*, *46*(10), 1345- 1361.

Willcutt, E. G., Doyle, A. E., Nigg, J. T., Faraone, S. V., & Pennington, B. F. (2005). Validity of the executive function theory of attention-deficit/hyperactivity disorder: a meta- analytic review. *Biological psychiatry*, *57*(11), 1336-1346.

Wittmann, M., & Paulus, M. P. (2008). Decision making, impulsivity and time perception. *Trends in cognitive sciences*, *12*(1), 7-12.

Wood, D. R., Reimherr, F. W., & Wender, P. H. (1985). Treatment of attention deficit disorder with DL-phenylalanine. *Psychiatry research*, *16*(1), 21-26.

World Health Organization. (1992). *The ICD-10 classification of mental and behavioural disorders: clinical descriptions and diagnostic guidelines* (Vol. 1). World Health Organization.

Zelazo, P. D., & Müller, U. (2002). Executive function in typical and atypical development. *Blackwell handbook of childhood cognitive development*, 445-469.