Examining The Dimension Of Time Perception In Relation To The ADHD Risk

Roberta Vasilev

s3843254

Department of Psychology, University of Groningen

PSB3E-BT15: Bachelor Thesis

Group number: 2a-14

Supervisor: Dr. M. Garcia Pimenta

Second evaluator: Dr. A. Fürmaier

In collaboration with: Bente Leenders, Sanne Specht, Emma Snoeren

& Lyan Wellinkvoorde

Month 06, 2022

Abstract

The focus of this research was to analyze a potential correlation between diminished temporal perception, one of the six proposed dimensions of hyperfocus, and self-reported ADHD scores. Inappropriate levels of inattentiveness and hyperactivity are hallmarks of ADHD, a neurodevelopmental disorder. Generally speaking, it can be classified as mostly inattentive, predominantly hyperactive, or combined, with inattentive being much more prevalent across all age groups (APA 2013). On the other hand, hyperfocus is an intense state of concentration on a task which obstucte the ability to switch your attention when it's necessary. Additionally, there is less indication of awareness of the environment or time. Consequently, it has been proposed that the risk of ADHD may affect the skewed time perception linked to hyperfocus. For researching this subject the following question was used: Does ADHD affect time perception in hyperfocus states? The study was conducted online with the usage of a survey consisting of five questionaires. The data was obtained from a convenience sample (N=368) formed by young adults (M 21.44, SD=3.69) with a similar educational level. A correlational test statistic was employed to analyze the relationships between the variables of interest (time awareness and ADHD risk), and descriptive statistics were used to interpret the demographic information of the participants. The findings show no correlation between the temporal awareness feature of hyperfocus and ADHD risk . The current research adds to the existing body of literature and improvements for the used questionnaire meant to measure the hyperfocus dimensions were made.

Keywords: time perception, hyperfocus, ADHD

Examining The Dimension Of Time Perception In Relation To The ADHD Risk

The paradox of the current debate around attention deficit hyperactivity disorder (ADHD) is that regardless of its prominence, its apparent triviality has led us to distrust its very existence (Thapar, Langley & Muñoz−Solomando, 2012). People who are unaware of the symptoms of ADHD might accuse the sufferers of being lazy, labeling them as daydreamers who are indifferent to "what really matters", discarding that inattention and/or hyperactivity-impulsivity interfering with functioning or development are hallmarks of ADHD (American Psychiatric Association, 2013). Alternatively, disregarding the complexities of this affection, some others will judge the affects' lack of punctuality or capacity to execute job-related tasks time-efficiently. While passing judgment on these individuals, the majority of mentally healthy people visit museums to admire the intricately detailed paintings, attend concerts to hear sounds they never imagined could come from a human's mouth, quietly watch life changing films, and listen to speeches that they proudly reference afterward. Surprisingly, the majority of the world's greatest works are created by people who do not follow a given set of rules (Thapar, Langley & Muñoz−Solomando, 2012), due to their innovative working methods that enabled them to achieve their objectives. However, hyperfocus—a phase of intense concentration that is longer-lasting, more frequent, or more intense than regular attentional focus—by channeling and unidirectionally mobilizing otherwise scattered energy and concentration flows, may have an impact on their creative outbursts (Ashinoff and Abu-Akel, 2019). Nevertheless, hyperfocus states are not entirely harmless, as they reduce the awareness of one’s surroundings, alter time perception, and can

lead to ignoring one's personal needs such as eating, sleeping, or using the bathroom (Ozel-Kizel et al., 2016; Sklar,2013; Hupfeld et al., 2018).

Despite the preconceptions surrounding ADHD, research has been able to explain the relationship between human action and the brain, in people who have the disorder. Consequently, the relationship between ADHD and hyperfocus can give researchers insights into subjective experiences of hyperfocus and ADHD, advancing the current studies on the topic. Of interest for this paper is one of the more recent studies demonstrating that while one is experiencing ADHD symptoms or hyper-focus states, their perception of time is altered (Groen et al., 2020;). Even though temporal distortion is a common sign of ADHD, this symptom is not officially listed in the diagnostic manuals (Ashinoff and Abu-Akel, 2019). Thus, the temporal dimension will be examined in greater depth in this paper in order to understand its importance to ADHD patients. In addition, as we try to measure the subjective time perception of people it should be kept in mind that time perception might not actually be equivalent to the actual time, a phenomenon that we can call distorted time perception. Thus, self-report measurements about time and actual time measures were used for measuring time perception.

Considering the above-mentioned information, the focus of this research paper will be organized around the following research question: Does ADHD affect time perception in hyperfocus states?

ADHD is a disorder characterized by problems with attention, overactivity, and impulsivity that begin in childhood. ADHD is a complex condition with an unknown origin, which affects 3-5% of children and adolescents. While, ADHD among adults has been estimated to be between 3.4 - 4.4 % (Fayyad et al., 2007; Kessler et al., 2006**).** Attention impairments are common in ADHD patients but are not the only impressed area. Although

concentration difficulties are the most common sign of ADHD, they can be a major hurdle in the diagnosis process since they mask other, less noticeable symptoms such as time blindness, hyperfocus, and executive dysfunctions (Weissenberger et al., 2019).

Earlier studies on ADHD investigated the concept of time blindness, a phenomenon where people are not aware of time passing. The results show that this condition is more often prevalent in clinical samples than in healthy populations (Barkley, 1997). The occurrence of time blindness, which implies an unawareness of time's passing and a lack of attunement to otherwise temporally structured events, can significantly affect one's daily life due to life's conventional resilience on time indices. While distorted time awareness and time blindness are related, distorted time awareness is more common in moments of hyperfocus, during which people lose their sense of time as a result of their strong focus on a particular job (Ashinoff & Abu-Akel, 2019; Barkley, 1997). Contrastingly, time blindness appears to be a more pervasive, day-to-day life problem, that is not co-constitutive with hyperfocus. Nevertheless, the two are closely related and studying them together can help us gain insight about how they manifest separately. Yet, what is of interest to this paper is how they both relate to hyperfocus.

Hyper-focus is a state in which a person is so engrossed in a task that they appear to ignore or 'tune out' from their immediate surroundings (Ozel-Kizel et al., 2016). It is most commonly reported in people who are engaged in a very enjoyable or stimulating activity (Hancock & Block, 2012). In addition, attention shifting is a difficult action to perform while experiencing states of intense focus. Although hyperfocus is frequently associated with autism, schizophrenia, and attention deficit hyperactivity disorder, there is little study on its impact on cognitive and neurological functioning (ADHD; Ozel-Kizel et al., 2016; Hupfeld et al., 2018). Accordingly, despite the fact that hyperfocus in ADHD patients is a common

symptom in clinical practice, it is not listed as an actual symptom in the diagnostic and statistical manual of mental disorders. (American Psychiatric Association,2013).

Hyperfocus, despite its apparent self-explanatory nature, is poorly documented in the literature. It is frequently left unlabeled, assuming that the reader is already aware of what it entails. As a result, there is no operational definition (Ozel-Kizel et al., 2016), which means no quantitative study can be conducted. Some potential definitions were found in a review of hyperfocus and merged into a more realistic definition. However, there is no official definition approved by the American Psychological Association. The definition that emerged from the mentioned review and will serve as a basis for this paper is: (1) hyperfocus is induced by task engagement; (2) is characterized by an intense state of sustained or selective attention; (3) diminishes perception of non-task relevant stimuli; and (4) improves task performance (ADHD; Ozel-Kizel et al., 2016; Hupfeld et al., 2018). The lack of documentation on this topic, influences the possibilities to further theorize its relation to other variables such as time perception, even if, as this paper will demonstrate and subsequent to the cited definition, there is a clear-cut connection between how hyperfocus impares our sensible apprehension of time. Consequently, we can hypothesize that people with a higher risk of ADHD are less aware of the objective time due to the diminished temporal awareness caused by hyperfocus.

Departing from these observations towards other sources which evidentate the link between hyperfocus and temporal perception, we can look at the terms interchangeability with "flow" – a term frequently used in positive psychology. This branch of psychology focuses on pleasant individual experience, positive individual characteristics, and positive institutions (Hupfeld et al., 2018), offering us a contrasting account to the aforementioned one, which would rather elaborate the negative consequences of this psychological phenomenon.

Correspondingly, the term “flow” defines a highly focussed mental state that benefited performance and positive self-image (Hancock & Block, 2012). Consequent to this alternative manner of investigation, a distinction between flow and hyperfocus is the flow's positive nature. Some of the implications of the flow state, such as autotelic experience, a skewed sense of time, a lack of self-consciousness, and a loss of self-consciousness, are viewed as beneficial (Hancock & Block, 2012). People considered the identical feelings to be unfavorable and out of their control when discussing hyperfocus, yet while describing their experiences time was in all cases referenced. This discovery demonstrates that various people have distinct subjective experiences when it comes to a comparable topic, making the quality of hyperfocus of being either positive or negative less important, while at the same time keeping consistent the experience’s dependence on time.

What is utmost interesting is that regardless of the terms synonymy or the positive/ negative connotations attached to it, what remains consistent is its evaluation in relation to time. An important similarity between flow and hyperfocus is the same activation criteria for accessing this state: a perceived challenge that offers the opportunity for progress and delivers immediate feedback braided with the loss of temporal and spatial awareness (Hancock & Block, 2012). Evidence shows that in both flow and hyperfocus states, time awareness is diminished by the task (Hupfeld et al., 2018). This might be happening due to the aspects mentioned in both the descriptions of flow or hyperfocus, namely, the absorption in a pleasurable, challenging task might alter the perception of time passing due to the reduced external stimuli. Thus, the similarities between flow and hyperfocus are doubledfold: first, they are both inseparable from time awareness and secondly, they reveal a common inability to objectively estimate time awareness. This obstacle has been reiterated by Hancock (2016) as well, by saying that: “time refers to an evident intangible quality” which makes it hard to

be studied as a dimension of experience. Therefore, this study will rely on subjective estimations of the phenomenon for measuring the alterability of time awareness. Irrespective of the intangibility of objectively measuring this temporal phenomenon, there are several other methods operating with a subjective expression of time experience. Among these,the following are the most prevalent in psychological research: verbal, productive, reproductive and by comparison. Verbal estimations were utilized to assess an individual's sense of time, asking participants to verbally indicate, via response, a specific time interval. Secondly, using productive measures, participants were requested to press a button when they had reached a specific time limit. Participants' perceptions were also measured and examined through the reproduction method. This method consists in evaluating the participant’s capacity to reproduce the researcher’s actions in a given order and time limit. Lastly, the comparison methods measured time awareness by setting up two different temporal durations, and asking the participants to indicate which of the two lasted longer (Ozel-Kizel et al., 2016).

To bring together ADHD, hyperfocus and time perception, we can look at the affectees' capacity to time shift. Time perception, more than an equivalent of time awareness, also implies the capacity to joggle with time representations (Zimbardo and Boyd 2014).
While most people can successfully move between their psychological past, present, and future states, benefiting from previous experiences while also being conscious of future responsibilities, people suffering from ADHD, due to an inconsistent temporal awareness, find it more difficult (Weissenberger et al., 2019). Learning, as well as social and professional success, necessitates the ability to shift between different time perspectives and use focus in a more consistent manner. Relating this to people's subjective time awareness, it's clear that their daily lives are impacted, as they report being late for meetings, not having enough time to meet deadlines, or simply feeling lost because they don't have a clear picture of their time.

(Weissenberger et al., 2019). In addition, people's skewed sense of time, due to possible ADHD symptoms, results in a slew of disputes, failures, job losses, disgruntled friends, and shattered romances, but it also in an uncanny capacity to perform effectively under duress, as well as being delightfully, infuriatingly ignorant to the time constraints that most people face. This can develop as well in social ostracisation which can lead to more psychological impairments such as depression or anxiety (Barkley,2020). The role that ADHD plays in the development of these conditions is that, due to focus being one of the most affected capacities in people diagnosed with this mental illness, it is common that distorted time perception occurs among people showing ADHD symptoms (Barkley, 1997). The subsequent implication is that people diagnosed with ADHD have a subjective perspective on time that differs from the objective one. Furthermore, the phenomenon has been studied by observing qualitative data and comparing their self-reports on time and the actual time measurements. The studies have rendered different results on how time was perceived, based on if the participant was or not suffering from ADHD, further demonstrating that time is distorted for the former category.

Many secondary symptoms such as affective impairments and time blindness associated with ADHD are not recognized in the DSM-5 as symptoms. Nevertheless, executive dysfunction is a defining element of ADHD, that is significantly impaired in people diagnosed with this mental condition (Weissenberger et al., 2019). In addition, some experts believe that ADHD is just a disturbed executive function, leading to a lack of capacity to complete daily tasks. This contributes to irritation and ineffective communication with others, which is linked to a disturbance in physical, cognitive, and emotional behavior (Ashinoff & Abu-Akel, 2019). Its aspects include inhibitory control, learning, memory, and set switching,

all of which are strong determinants of academic and social outcomes in adults with ADHD (Fenesy and Lee 2018**;** Rohlf et al. 2012).

Following Barkely and Benton (2013), the connection between ADHD, hyperfocus and time perception, is strengthened due to time perception being deeply intertwined with executive functioning. Because executive function necessitates the ability to plan for the future, it is inextricably linked to time perception and is usually evaluated using a lucrative temporal framework. In addition, Hurks and Hendriksen (2011) hypothesized that discrepancies in reported time estimations caused by ADHD could be attributable to a disturbance of the internal clock, strengthening the correlation between ADHD, the brain's executive function, and temporal awareness. From subjective reports we learn that people with ADHD have the illusion that time is passing through their arms or that it is flying too quickly (Weissenberger et al., 2019), as well as, following the previous paragraphs, that during hyperfocus, time freezes. On the other hand, in some studies, such as those conducted t using a three way model (Toplak et al., 2012)**,** time perception deficits are considered independent from the executive function. Yet, following the previous theoretical accounts, this study distrusts the possibility of their separation and supports their co-dependence. This research will thus use a psychological configuration where time perception is part of the brain's executive function and, for its inquiry, operate with the hypothesis that given the executive function impairment in people with ADHD risk, time perception is also affected.

In this study we will utilize two types of assessment to examine how the presence of ADHD features affects the time perception dimension of hyperfocus, namely, an ADHD screener and the dimension of time awareness of the hyperfocus questionnaire. The premise established in this work is that hyperfocus is a multidimensional construct, meaning that more

individual dimensions will be measured individually, based on past research. With the aim to understand the concept of time awareness individually of other dimensions of hyperfocus, this study will focus on the 'time and self' dimension in relation with the ADHD risk.

Methods

Participants

Participants are obtained through convenience samples via the SONA first-year pool of the University of Groningen (n = 249), the paid participant pool (PPP; n = 84), and through social media (n = 35). This yields a total sample size of N = 368 before exclusion. Participants are excluded if they report insufficient language abilities (n = 1), if they report to not have answered the questions seriously (n = 5), if they fail one of the three validity control questions (n = 20), if they do not complete the questionnaire (n = 32) or if they do not consent to participation (n = 22). The final sample size is N = 322, with 240 female, 79 male and 3 participants who identified as 'other'. The age ranges from 18 to 54 with a mean of 21.44 (SD = 3.69). The level of education was coded by a bachelor thesis group and a master student separately via the International Standard Classification of Education System (ISCED; ISCED, 2011). The Cohen's kappa is .939, which is considered as excellent inter-rater reliability. Level of education ranges from the levels 3 ("upper secondary education") to 7 ("master or equivalent"), with mode education level being 5 ("short-cycle tertiary education"). 152 participants reported Dutch as their first language (47.2%), 68 reported German (21.1%), and 22 reported English (6.8%). Additionally, various reported other languages (e.g. Frisian, Romanian, Greek, Hebrew), which are categorized as "other" (24.8%). The participants also reported if they were ever diagnosed (n = 98), and/or currently have a diagnosis or received treatment for psychological, mental or brain disorders by a mental health professional (n = 46) and/or used prescribed medication (n = 29). Several diagnoses are reported that were then

categorized, e.g. ADHD (*n* = 16), anxiety disorder (*n* = 39) and mood disorders (n = 38). Next to this, they reported on the use of various substances, namely alcohol (*M* = 2.81, *SD* = 1.24), nicotine (*M* = 2.19, *SD* = 1.51), drugs (*M* = 1.82, *SD* = 1.10), and abuse of prescription medication (*M* = 1.23, *SD* = 0.77).

Measures

Demographic information

Via open questions in English, participants are instructed to self-report demographic data such as age, nationality, first language, highest level of education attained and in which country they attained this education. Furthermore, participants are asked to categorize their sex as either "female", "male" or "other". Lastly, they are instructed to categorize their current occupational status based on nine answer options, including an "other" option, where they could fill it in themselves if theirs is different from the options provided.

Core Hyperfocus questionnaire

For assessing the various dimensions of hyperfocus among participants, an experimental version of the Core Hyperfocus questionnaire is applied. Participants are instructed to indicate the frequency of specific hyperfocus experiences in the past six months, on a 6-point Likert scale (1 = never, 6 = very frequently/always). This questionnaire incorporates eight dimensions of hyperfocus: 'reduced awareness of the world' (6 items, α = .85), 'reduced awareness of time' (6 items, α = .82), 'reduced awareness of the self' (6 items, α = .76), 'narrow focus' (6 items, α = .78), 'deep and intense focus' (4 items, α = .75), 'stopping and initiating other things' (6 items, α = .34), 'automatic focus' (6 items, α = .86) and 'prolonged concentration' (6 items, α = .72), with a total of 46 items (α = .95). Examples of items are; "I can be so focused on something that I do not notice the world around me'' (world awareness) and "There are times when I feel trapped or locked in a state of deep

concentration'' (stopping and initiating other things). Two validity control questions are included, which instruct participants to choose the answers "rarely" and "sometimes" in order to indicate attentive responding. Item order is randomized to reduce the probability of order and fatigue effects. To summarize the scores for these hyperfocus dimensions, the scores of each question are summed up, and divided by the amount of questions per dimension.

Adult ADHD self-report scale screener (ASRS-S)

To measure the risk for ADHD of the participants we use The World Health Organization ASRS-S (Kessler et al., 2005). This is a shortened version consisting of six items from the full ASRS, which contains 18 items. The ASRS assesses the prevalence of common symptoms of ADHD and therefore the potential risk for an ADHD diagnosis. The items are based on the criteria for ADHD as described in the DSM-IV (American Psychiatric Association, 1994) and input from clinical experts. The items are measured on a 6-point Likert scale (1 = never, 6 = very often). Participants are asked to self-report these symptoms over the last six months. Examples of items included are: "How often do you have difficulty getting things in order when you have to do a task that requires organization?" and "How often do you feel overly active and compelled to do things, like you were driven by a motor?". A validity control question was included which instructed participants to choose the answer "often" to indicate that their responses were attentive. The ASRS-S summary score consists of the sum of these six individual item scores. Validity research by Kessler et al. (2007) showed Cronbach's alpha ranged from 0.63 to 0.72. This research identifies a Cronbach's alpha of 0.66.

Personal information questionnaire

The questionnaire includes items regarding personal information. Participants are instructed to self-report whether they have ever been diagnosed or received treatment for a

psychological, mental or brain disorder, and whether this diagnosis was obtained in the last six months. If the response is yes, they are asked to specify which disorder(s). In addition to that, an inquiry is done regarding the use of prescribed medication, and the specific type of medication which was prescribed. Considering the sensitive nature of these questions, participants are given the option to skip any questions they did not feel comfortable answering.

The Tobacco, Alcohol, Prescription medication, and other Substance use (TAPS) tool

Furthermore, four questions of the TAPS screening tool (Adam et al, 2019) are used to examine the frequency of substance use, including tobacco/other forms of nicotine, alcohol, drugs or the abuse of prescribed medication in the last six months. An example of an item is "In the past 6 months, how often have you used tobacco or any other nicotine delivery product (i.e., e-cigarette, vaping or chewing tobacco)?" These are assessed by a 5-point Likert scale (1 = never, 5 = daily or almost daily). Considering the sensitive nature of these questions, participants were able to leave any of these questions open if they did not feel comfortable answering.

Procedure

The full survey is administered online, and takes approximately fifteen minutes to complete. Participants gain access to the online Qualtrics (https://www.qualtrics.com) questionnaire through a link and complete it unsupervised. Participants gaining access through SONA receive mandatory study credits as compensation. Participants gaining access through the PPP received €2.00 as compensation. Lastly, other participants are approached via social media (e.g. Facebook, Whatsapp), but not compensated. All relevant aspects of the study were approved by the Ethics Committee of the Faculty of Behavioral and Social Sciences of the University of Groningen.

The questionnaire starts with information of the study, after which participants give informed consent to participation and to collection of personal data (e.g. IP address). First, participants answer questions regarding demographic information. Then, the core hyperfocus questionnaire is presented. In addition to the core hyperfocus questionnaire, participants are instructed to estimate the average duration of a single hyperfocus experience in hours and minutes. Then the ASRS-S is administered, followed by additional personal information questions and the TAPS screening tool. In addition to the validity control questions, two final quality control questions are included at the end of the questionnaire to control for attentive responding. Participants are instructed to report whether they responded seriously and if their English language skills were sufficient to reliably fill in the questionnaire. The final phase is a debriefing in which participants are informed about the research's purpose.

Data analysis

The next stage after data collection was data analysis. The data was analyzed using version 26 of the SPSS Statistics program. Based on the exclusion criteria, unwanted participants who might skew the results are excluded from further analysis. The exclusion criteria for this study are mentioned in the participant's section. Descriptive statistics were computed in order to have a better understanding of the sample. Thus, age, sex, nationality, and educational level were examined.

To test the hypothesis of this paper, a Pearson's correlational coefficient was computed between the ASRS average scores and the "Time awareness" component of hyperfocus. For computing, this statistical test, one new variable named 'time awareness_avg' was computed and the values of each participant were correlated with the ADHD score. The variable 'time awareness_avg' was computed by using the results of the relevant items for time perception and dividing them by six, the number of time awareness items. In addition, another variable

named “ Screener_avg” was computed in order to obtain the ADHD score. The ADHD score was obtained for each participant by calculating the average score of their answers to the ASRS questionnaire.

To confirm that the parametric data fit the correlational model, the assumptions were double-checked. Linearity, homoscedasticity, and normality were checked using residual vs predicted plots, QQ plots, and histograms. The results from the previously mentioned procedures showed that the data is linear and normally distributed. Two outliers were present in the data, however, they were not excluded as they did not influence the data significantly.

In order to check for other variables that might have an influence on the results, a correlational matrix between the demographic data (medication consumption; diagnosed mental health issues; age; sex) and the hyperfocus score was computed. The mentioned variables were taken from the participant’s responses and new variables were created for analyzing the data. Namely, the variable “Diag_new” represents whether or not in the past 6 months the participants have been diagnosed or received treatment for a psychological, mental, or brain disorder by a mental health professional. Similarly, the variable used for observing whether or not the participants are taking medication was renamed “nMedication”. This variable was used in order to see if, in the past 6 months, participants have been taking medication for a psychological, mental, or brain disorder, prescribed by a mental health professional.

Results section

Descriptive statistics

The demographic information on the participants' age was also examined and can be seen in table 1. In addition, table one presents information on the descriptive statistics of the time awareness dimension and ADHD screener score. The data used for this study is formed of young people (M=21.44 SD= 3.69) . In addition, the majority of the sample is formed by female participants (87.2%) followed by male participants (10.6%) and other gender participants (2.1%). Participants that are diagnosed with a mental disorder represent 15.2 % of the total sample and 8.9% of them received medication in the past six months.

Table 1

Descriptive Statistics For The Time Awareness Dimension of Hyperfocus, ADHD Screener Scores and Demographic Variables (Age).

	Time awarness_avg	ADHD screener_avg	Age
Mean	3.536	2.109	21.44
Std.deviation	811	652	3.689
Minimum	1.00	0.33	18
Maximum	6.00	4.00	54

The ADHD screener score (M= 2.109; SD= .6522) was generated in order to get a clear perspective of the collected data. The identical technique was utilized for the hyperfocus questionnaire dimension "temporal awareness" (M= 3.54; SD=.811).

Inferential statistics

Pearson product correlation of ADHD score and "time awareness" dimension of hyperfocus was found to be very weakly correlated and nonsignificant (*r=.102. p=.068*). Hence, H1: there is a significant relationship between ADHD score and the time perception dimesion of hyperfocus is not supported by the data.

A correlational matrix was created to determine whether the findings were influenced by demographic data or unexamined hyperfocus dimensions. Table 2 provides the values for the mentioned correlations. Table 2 shows a negative correlation (*r =-.114. p= 0.41*) between the age of the paticioants and the time awareness dimension. Having a mental diagnosis received or the usage of medication did not correlate with neither the ADHD screener score or with the time perception dimesion.

Table 2

Pearson Correlations Between Time Awareness, ADHD Screener Score, Sex and Age.

	1.	2.	3.	4.	5.	6.
1.Time awarness_avg	-					

2.Screener_avg	.102				
3.Age	0.33	-.114*			
4.Sex	.008	-.045	.190**		
5.Diagnosis_new	0.95	.128	-.159	-.073	
6.nMedication	-.028	.109	.023	-.055	.347**

Note. ** $p < .01$.

* $p<.05$.

Discussion

In the present study, the time perception dimension of hyperfocus was investigated in relation with the ADHD risk. However, the data did not support this hypothesis meaning that no significant correlation was found between the risk of ADHD and distorted time perception present due to hyperfocus states. On the other hand, earlier research on ADHD in both children and adults has also highlighted these patients' poor time estimation. These people frequently stutter under the organizational demands of daily living due to their poor time awarness. They frequently arrive late, hurried, and unprepared due to their "time-blindness" (Barkley, 1997; Verbeeck, 2003). Additionally, the studies on time perception in ADHD patients revealed that they had trouble interpreting time information. For these individuals, time estimation, time production/reproduction, and discriminating tasks were used to test time perception abnormalities. Only a few studies looked at the capacity for time perception in adults with ADHD, and these investigations produced mixed findings (Barkley, Murphy, & Bush, 2001; Seri, Kofman, & Shay, 2002). Namely, Barkley et al (1996), found no

correlation between the dimension of time and ADHD in adults. However, Seri, Kofman, & Shay (2002), found results that show that time awareness was impaired in adults reporting ADHD symptoms. Furthermore, Groen et al. (2020) found a small positive correlation between hyperfocus occurrence and reported ADHD scores. The same findings were visible in Hupfeld et al. (2018) study where throughout numerous settings, dimensions, and real-world circumstances, those with more severe ADHD symptomatology have greater HF tendencies. However none of the studies, focussed only on the dimension of time, making the limited research more difficult to compare with our already non-significant results.

Furthermore, the demographic information, medication usage and clinical diagnosis were used in order to analyse the relationship between ADHD risk and the time awareness dimension of hyperfocus. In addition, this statistical analysis might have provided insights into possible confounding variables. Regarding this analysis, we observed that the age of the participants was found to be negatively correlated with the ADHD risk. However, this might be due to a number of environmental factors that people with ADHD symptoms may experience throughout their life and which could promote greater functional functioning. In addition, a positive correlation was found between the medical diagnosis received in the last six months and medication usage for the same period. Namely, from the statistical analysis used in this study, we have observed that receiving a diagnosis might influence the medication usage.

The data analysis showed that more women than other sexes were involved in this study and that the average age for the participants is 21,5 years old. However, the medication did not seem to have an influence on the correlation with the time awareness dimension of the hyperfocus scale. In addition, no correlation was found between the age and the time

awareness dimension of hyperfocus. This can be happening due to the sample not being diverse enough, as the majority of the participants were college students . Further research needs to be done on a sample with different educational and age ranges. In addition, now that the dimension of time awareness was examined individually, the other five dimensions of hyperfocus should be researched too for a better overview of the hyperfocus dimension. In contrast with our findings on the demographic variables, Groen et al. (2020) found that age, sex, and educational level have a role in how often and how intense hyperfocus states are. However, the discrepancies between this study and the above-mentioned studies can be explained by various methodological and conceptual reasons that will be explained in the next paragraph.

Limitations and future directions

Given that almost half of the sample was made up of Dutch citizens, one limitation of our study is the underrepresentation among some nations. In addition, the used data was formed by mostly females as shown in the results section. As a result, it is difficult to say whether or not this study is representative of the entire world adult population. Another disadvantage of the convenience sampling study is the possibility of biases due to the sampling design. Possible biases can arise due to some people choosing not to participate while others do. Furthermore, biases such as the third variable problem might have a negative impact on the outcomes. This effect could be applicable for this study due to analysing only the time perception dimension of hyperfocuss in relation with ADHD risk while the other five dimesions of hyperfocus are left unexamined. Additionally, the study did not analyze the precise medical diagnosis received or type of medication taken, both of which would have affected the results. Even though considerable associations were discovered in other studies

(cource), the demographic characteristics were not as connected with the ADHD risk or hyperfocus scores in our study. This could be due to a failure to appropriately examine all the confounding variables mentioned above.

The different definitions and operationalizations of the hyperfocus concept among already existing studies could form a conceptual cause for the disparate findings. Given that time perception is a co-constitutive part of hyperfocus, the lack of a general definition of the latter, is a drawback of this study, as it influences our possibility to address the relationship between the two. As previously stated, this can pose a number of problems regarding the methods or interpretations used to study distorted time awareness. Each previous study used a different definition and focussed on various different parts of the hyperfocus dimension. However, no study focussed only on the distorted time awareness dimension of hyperfocus. Thus, an exact comparison of results can not be made. Hupfeld et al. (2018) focused on the difficulties transitioning between tasks and incapacity to care for oneself, whereas (Ashinoff & Abu-Akel, 2019) noted that activities should seem interesting and pleasant in order to achieve hyperfocus. Other scholars attempted to identify hyperfocus by focusing on procrastination and time management challenges (Ozel-Kizel et al., 2016). Thus, all the differences in results can be due to the usage of an uncommon definition for the same concept.

Before going further with examining the limitations of our study, it is important to acknowledge that the hyperfocused questionnaire employed in this study (Ozel-Kizel et al., 2016) can pose methodological flaws for the present study because it was created by clinicians observing ADHD patients (Groen et al., 2020). Due to this, it's probable that the developers disregarded hyperfocus data from a non-clinical population, which is important to

take into account for our study. The lack of results on time awareness in our study might be indeed due to the need of different measurements in non clinical population than in clinical populations. Examining the dimension of time is similarly challenging and might lead to misinterpretation of the findings (Hancock & Block, 2012). Even if subjective and objective time measurements have been produced, participants and researchers must utilize them with caution. This sensitive variable could potentially be to blame for the discrepancies in results.

Considering all of the aforementioned limitations, more research on the subjective experience with hyperfocus, time, and ADHD should be done in order to enrich the understanding of the topic.

Importance and Implications

This study contributes to the limited research on the distorted time awareness dimension of hyperfocus. In addition, it accounts for the subjective experience of time perception. Thus, the individual differences can be better observed through this study. This betterment can improve the validity of the study as the participant's responses are analysed from different perspectives than before. involved.

References

Adam, A., Schwartz, R. P., Wu, L. T., Subramaniam, G., Laska, E., Sharma, G., Mili, S., & McNeely, J. (2019). Electronic self-administered screening for substance use in adult primary care patients: feasibility and acceptability of the tobacco, alcohol, prescription medication, and other substance use (myTAPS) screening tool. *Addiction Science & Clinical Practice*, *14*(1). https://doi.org/10.1186/s13722-019-0167-z

American Psychiatric Association. (1994). Diagnostic and statistical manual of mental disorders (4th ed.).

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed.).

Ashinoff, B. K., & Abu-Akel, A. (2019). Hyperfocus: The Forgotten Frontier of Attention. *Psychological Research*, *85*(1), 1–19. https://doi.org/10.1007/s00426-019-01245-8

Barkley, R. A. (1997). Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. *Psychological Bulletin*, *121*(1), 65–94. https://doi.org/10.1037/0033-2909.121.1.65

Barkley, R. A. (2020). *Taking charge of Adhd: The complete, authoritative guide for parents*. The Guilford Press.

Barkley, R. A., & Benton, C. M. (2022). *Taking charge of adult Adhd: Proven strategies to succeed at work, at home, and in relationships*. The Guilford Press, a division of Guildford Publications, Inc.

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. https://doi.org/10.1177/108705479600100104

Fenesy, M. C., & Lee, S. S. (2018). Executive functioning mediates predictions of youth academic and Social Development from parenting behavior. *Developmental Neuropsychology*, *43*(8), 729–750. https://doi.org/10.1080/87565641.2018.1525384

Groen, Y., Priegnitz, U., Fuermaier, A. B. M., Tucha, L., Tucha, O., Aschenbrenner, S., Weisbrod, M., & Garcia Pimenta, M. (2020). Testing the relation between ADHD and hyperfocus experiences. *Research in Developmental Disabilities*, *107*, 103789. https://doi.org/10.1016/j.ridd.2020.103789

Hancock, P. A., & Block, R. A. (2012). The Psychology of Time: A view backward and forward. *The American Journal of Psychology*, *125*(3), 267–274. https://doi.org/10.5406/amerjpsyc.125.3.0267

Hancock, P. A., Kaplan, A. D., Cruit, J. K., Hancock, G. M., MacArthur, K. R., & Szalma, J. L. (2019). A meta-analysis of flow effects and the perception of Time. *Acta Psychologica*, *198*, 102836. https://doi.org/10.1016/j.actpsy.2019.04.007

Hupfeld, K. E., Abagis, T. R., & Shah, P. (2019). Correction to: Living “in the zone”: Hyperfocus in adult ADHD. *ADHD Attention Deficit and Hyperactivity Disorders*, *11*(2), 209–209. https://doi.org/10.1007/s12402-019-00296-6

Kessler, R. C., Adler, L., Barkley, R., Biederman, J., Conners, C. K., Demler, O., Faraone, S. V., Greenhill, L. L., Howes, M. J., Secnik, K., Spencer, T., Ustun, T. B., Walters, E. E.,

& Zaslavsky, A. M. (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. https://doi.org/10.1176/ajp.2006.163.4.716

Kessler, R. C., Adler, L. A., Gruber, M. J., Sarawate, C. A., Spencer, T., & Van Brunt, D. L. (2007). Validity of the World Health Organization Adult ADHD self-report scale (ASRS) screener in a representative sample of health plan members. International Journal of Methods in Psychiatric Research, 16(2), 52–65.

Ozel-Kizil, E. T., Kokurcan, A., Aksoy, U. M., Kanat, B. B., Sakarya, D., Bastug, G., Colak, B., Altunoz, U., Kirici, S., Demirbas, H., & Oncu, B. (2016). Hyperfocusing as a dimension of adult attention deficit hyperactivity disorder. *Research in Developmental Disabilities*, *59*, 351–358. https://doi.org/10.1016/j.ridd.2016.09.016

Rohlf, H., Jucksch, V., Gawrilow, C., Huss, M., Hein, J., Lehmkuhl, U., & Salbach-Andrae, H. (2011). Set shifting and working memory in adults with attention-deficit/ hyperactivity disorder. *Journal of Neural Transmission*, *119*(1), 95–106. https:// doi.org/10.1007/s00702-011-0660-3

Thapar, A., Langley, K., & Muñoz−Solomando, A. (2012). Theadhddebate: Being mindful of complexity and wary of reductionist explanations and polarization. *Journal of Family Therapy*, *35*(2), 219–223. https://doi.org/10.1111/j.1467-6427.2012.00608.x

Toplak, M. E., Sorge, G. B., Flora, D. B., Chen, W., Banaschewski, T., Buitelaar, J., Ebstein, R., Eisenberg, J., Franke, B., Gill, M., Miranda, A., Oades, R. D., Roeyers, H., Rothenberger, A., Sergeant, J., Sonuga-Barke, E., Steinhausen, H.-C., Thompson, M., Tannock, R., … Faraone, S. V. (2011). The hierarchical factor model of ADHD:

Invariant across age and national groupings? *Journal of Child Psychology and Psychiatry*, *53*(3), 292–303. https://doi.org/10.1111/j.1469-7610.2011.02500.x

Weissenberger, S., Klicperova-Baker, M., Vňuková, M., Raboch, J., & Ptáček, R. (2019). ADHD and time perception: Findings and treatments. *Activitas Nervosa Superior*, *61*(3), 131–135. https://doi.org/10.1007/s41470-019-00027-2

Unesco. (1976). *International Standard Classification of Education (ISCED)*. Paris: Unesco.

Zimbardo, P. G., & Boyd, J. N. (1999). Zimbardo Time Perspective Inventory. *PsycTESTS Dataset*. https://doi.org/10.1037/t01397-000

Appendix A

The Appendices appear here (if applicable). If your paper has more than one Appendix, you label them "Appendix A", "Appendix B", etc. If there is only one Appendix, you just label it Appendix. There is no fixed format to use in the Appendices, as the content may vary. Where possible use APA7 style.