To what extent can different dimensions of hyperfocus predict the risk of ADHD?

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Abstract

Patients with Attention-deficit/hyperactivity disorder (ADHD) often experience so-called paradoxical hyperfocus (HF) phenomena: prolonged moments of concentration in which they get completely engrossed in a specific task and in which there is a diminished perception of non-task relevant stimuli. This study aims to investigate the association and predictive value of eight hyperfocus dimensions for the risk of ADHD: 'reduced awareness of the world' 'reduced awareness of the time' 'reduced awareness of the self', 'narrow focus', 'deep and intense focus', 'stopping and initiating other things', 'automatic focus' and 'prolonged concentration' through a preliminary self-report containing 46 questions: the Core Hyperfocus questionnaire. The risk of ADHD is examined with the ASRS-S, containing six questions. Performing a simple multiple linear regression, the study shows that all dimensions together explain a significant amount of variance in the risk of ADHD. Additionally, less 'awareness of the time' and less 'awareness of the self' initiates an increased risk of ADHD and more 'automatic focus' indicates a decreased risk of ADHD. Further research is needed to find more empirical evidence for different dimensions of HF and investigate if they are possibly linked to negative and positive consequences, as negative consequences might be stronger related to HF.

Keywords: Hyperfocus, ADHD, Adult ADHD, Flow

To what extent can different dimensions of hyperfocus predict the risk of ADHD?

If you had to describe a stereotypical attention-deficit/hyperactivity disorder (ADHD) patient, one of the most thought of elements perhaps would be the inability to focus. Considering that ADHD is primarily expressed by impairments in sustaining attention, this is not much of a surprise. ADHD is a neurodevelopmental disorder, which is, besides distractibility, characterized by hyperactivity and/or impulsivity interfering with the regular functioning or development and which can persist into adulthood (American Psychiatric Association, 2013). Yet, some suggest that ADHD is not a deficit in attention but rather a dysregulation, due to maldistribution of attentional resources (Leimkuhler, 1994). Individuals with ADHD regularly seem to experience prolonged moments of concentration in which they get completely engrossed in a specific task or moment; a phenomenon called hyperfocus (HF).

HF is further characterized by an intense state of deep sustained or selective attention on a task and/or object as opposed to regular attention. Once completely engrossed in the task and/or object, there is a diminished perception of non-task relevant stimuli. HF experiences do not solely belong to ADHD patients, but they are common in the neurotypical population as well (Ashinoff & Abu-Akel, 2021). According to Conner (1994), the phenomenon is more chronic and frequent in ADHD patients such that it is causing dysfunction. Since 93 per cent of adult ADHD patients report inattention as a symptom the phenomenon of HF in ADHD sounds paradoxical and poses a challenge to the current vision on the attention problems (Millstein et al., 1997). Yet, the scarce research available does show that there is an association between HF and ADHD (Ozel-Kizil et al., 2016; Hupfeld et al., 2018; Grotewiel et al., 2021). HF is in prior studies approached as a construct with different dimensions; those dimensions concerning elements associated with focus (e.g. losing track of time). None of those are scientifically

established yet. Although a number of studies initiated research about the phenomenon of HF, most of the ADHD literature is still focused on such distractibility, impulsivity and hyperactive symptoms within this disorder (e.g. Quiros & Kinsbourne, 2006), whereby HF has yet to be well-characterized.

The notion of HF is often deduced from popular media sources (e.g. Maucieri, 2014) and anecdotal case studies, as this term is insufficiently established and lacks empirical evidence. Expanding knowledge about HF is of great value, as future research would benefit from having a clear and testable definition on which research can be built further. The derived information also has the potential to guide and improve clinical treatments for ADHD. If HF would be considered in the diagnosing process for ADHD, the sensitivity and the specificity of the diagnosing process has the possibility to increase, as the occurrence of HF might misdirect an accurate ADHD diagnosis, considering its great contrast with the core distractibility symptom of ADHD (Asherson et al., 2012). Furthermore, HF is frequently reported as an unofficial symptom in the context of Autism Spectrum Disorder (ASD) (e.g. Panagiotidi et al., 2017) and in Schizophrenia (e.g. Luck et al., 2019) and thereby may be a transdiagnostic factor. Investigating HF can lead to a better understanding of the cognitive dysfunctional attentional processes in ADHD, but also in ASD and Schizophrenia. By strengthening the empirical base of the multidimensional nature of HF, further clarification can be provided about whether specific dimensions are more associated with certain disorders.

So, prior research laid the foundation for the idea of HF being a multidimensional construct, even though its defined dimensions are still preliminary and under development. In our research, we aim to further deepen our understanding of HF by investigating how each of the eight preliminary dimensions of HF can predict the risk of ADHD. Furthermore, we highlight the

influence of the combined dimensions to create a holistic image. We use the Core Hyperfocus questionnaire, which is still in its developmental phase, to distinguish HF from its situational, motivational and task related determinants and possible positive and negative consequences. With this research, we try to provide support for this questionnaire by testing the following dimensions: ‘reduced awareness of the world’ ‘reduced awareness of the time’ ‘reduced awareness of the self’, ‘narrow focus’, ‘deep and intense focus’, ‘stopping and initiating other things’, ‘automatic focus’ and ‘prolonged concentration’. Within this questionnaire, it is tried to distinguish HF from its situational, motivational and task related determinants and their possible positive or negative consequences, to measure the core of HF. The risk of ADHD is separately measured, this will be elaborated upon later. Overall, we hope to answer the following research question with this study: to what extent can different dimensions of hyperfocus predict the risk of ADHD?

Literature review

According to the cognitive-energetic model (CEM), neuropsychological deficits in ADHD can be explained by over- and under-activation of the optimal energetic state. If there is a discrepancy between the task demands and the energetic state, effortful control is needed (Sergeant, 2005; Van Der Meere, 2005). HF can be explained by the CEM as overactivation of the energetic state without the requirement of effortful control (Groen et al., 2020).

According to Ashinoff & Abu-Akel (2019), the concept of HF is possibly operating under alternative names in the literature, such as ‘flow’. Exploring literature on flow can be relevant in our case, because if similarities between the two constructs are high, further research can build on ‘flow episodes’ literature as well. Csikszentmihalyi & Csikszentmihalyi (1992) reported that flow is mainly focused on the enjoyment and the quality of the performance; this gave

foundation to the statement that HF is more often mentioned in the context of psychopathology and flow in the context of everyday life (e.g. Ashinoff & Abu-Akel, 2019). Thus, HF is often associated with negative consequences (e.g. forgetting personal needs), while this is often not the case with flow (Ozel-Kizil et al., 2016). The research of Hupfeld et al. (2018) demonstrated that people who are frequently experiencing HF, also frequently experience flow, but this is not the case the other way around. Also, flow scores do not show a significant correlation with adult ADHD characteristics, while HF does. Thus, according to Hupfeld et al. (2018), HF can be seen as 'deep flow', which has its own characteristics but further research is necessary to fully understand the relationship between HF and flow.

Sklar (2013) firstly demonstrated the phenomenon of ADHD patients being engaged for longer and more intense with a task within an exploratory study. It was implied that HF is mainly context dependent; the task has to be located in the area of interest of the participant. They utilized an electroencephalography (EEG) during HF to reveal lower alpha and beta levels in the ADHD group. Those possible neurological markers for HF can potentially support the fact that HF is indeed more prevalent in ADHD, but additional research is needed. An interesting finding was the significantly distorted time perception during the playing of a videogame compared to controls. Limitations of this study express themselves in the small sample size and the fact that HF is rather hard to simulate in an experimental setting. Hence, for our study, a questionnaire is used instead of an EEG and our sample size is more adequate.

As we are developing a new HF questionnaire, it is important we look critically at the previous ones. Ozel-Kizil et al. (2016) developed an eleven item HF scale (Likert scale) to assess the severity of HF symptoms. This study identified more HF in adults with ADHD, compared with healthy controls. In the questionnaire, mainly negative consequences of HF were included,

such as ‘impaired time management’ and ‘procrastination’. This might lead to rather measuring impairments in certain executive functions or measuring the consequences of HF, then measuring the concept of HF itself (Groen et al., 2020). To avoid this, we are using a more neutral questionnaire. It can be stated that our dimension ‘awareness of time’ originated from this study’s dimension ‘impaired time management’.

The second HF questionnaire is the Adult Hyperfocus Questionnaire (AHQ) by Hupfeld et al. (2018). In this questionnaire, six hyperfocus dimensions were linked to three different settings and thereby, the first working definition of HF is developed. Some evidence is found for higher HF scores in several settings, dimensions and real-world scenarios (e.g. screen time). It provides evidence for HF being an independent feature of adult ADHD and thereby, indications of strong HF in certain scenarios, came out being the strongest predictor for ADHD. More research is needed before this can be used as a separate short-form HF questionnaire. Also, Hupfeld et al. (2018) stated that it is unclear if HF is problematic or desirable, but Grotewiel et al. (2021) built further upon this and found HF being conceptualized as sometimes-problematic ‘deep flow’, considering the negative consequences of HF. They found support for four consequences, two of them are similar to dimensions in our study: ‘lost time’ and ‘difficulties switching tasks’. In our study, scenarios and consequences of HF are not directly taken into account, as we aim to have a less narrow questionnaire and want to investigate HF apart from its context. The majority of the dimensions in our core HF questionnaire did came from the following dimensions in the study of Hupfeld et al. (2018): ‘losing track of time’, ‘difficulty stopping and moving on to new task’, ‘failing to notice the world around you’, ‘feeling totally engrossed in the task’ and ‘getting stuck in small details’

The study of Groen et al. (2020) examined HF through ‘occurrence’, ‘frequency’, ‘duration’ and ‘pervasiveness’ among several situations and contexts, within ADHD patients and in the healthy population.. In healthy adults, the frequency of HF was positively correlated with ADHD traits, but no strong evidence was found for HF occurring more in ADHD patients. This might be explained by their measures used: single items exhibit lower reliability than scales and therefore, we chose to occupy our questionnaire with scales. Similar to our study, Groen et al. (2020) do not include consequences of HF either, which also might have caused the lack of significant results.

Hypothesis

As we are conducting exploratory research, there is not much in-depth prior research available about the eight defined dimensions of HF. Considering that the current HF research is still somewhat preliminary, it does not allow us to make specific predictions about the HF dimensions separately and those results cannot assist a well-established hypothesis. However, our research will lead to a greater understanding of the topic and reveal possible relationships between HF dimensions and the risk of ADHD. However, no definite results can be yielded as the research is still exploratory. Thus, it can be hypothesized that all eight HF dimensions together do explain a significant amount of variance for the risk of ADHD (hypothesis 1). This is based on the findings of the preliminary HF questionnaires of Ozel-Kizil et al. (2016), Hupfeld et al. (2018) and Grotewiel et al. (2021), as they established that HF is more prevalent in ADHD patients than it is in the general population.

Overview of the studies

In overview, this study aims to elaborate on the relationship between multiple dimensions of HF and the severity of ADHD, by assessing their predictive value. We aim to answer our

research question by the Core Hyperfocus questionnaire, which measures eight constructs of HF. Post-research evaluation can contribute to a better-shaped questionnaire, and work towards a more empirical and multidimensional definition of HF.

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 most 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 5-point Likert scale (1 = never, 5 = 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 data is analyzed using the software IBM SPSS Statistics version 26.0.0.1. For the power analysis, the software G*power,version 3.1.9.7 is used. We find a power of 0.99, calculated based on a multiple regression with eight predictors, with a sample size of n = 322, α = 0.05 and a calculated medium effect size (f^2 = .23). The research is exploratory and additionally one hypothesis is tested, using standard multiple linear regression analysis (MRA). Hyperfocus dimensions scores and ASRS-S scores are the experimental variables, with demographic data, personal information questions and the TAPS screening tool as control variables. Participants deviating more than 3 SD from the mean were excluded from the data set to analyze the data properly. The multivariate outliers are detected via the ‘Casewise Diagnostic’

function on SPSS and thus participant number 155 and 271 are eliminated. Additionally, the ASRS-S variable is calculated as a mean score per participant, this varies from what was previously mentioned in the measures.

It needs to be determined whether correct conclusions can be drawn from the data and therefore several assumption checks are conducted. Firstly, the multivariate normality of the data is examined. When displaying all HF constructs together in a scatterplot (y = standardized residual, x = standardized predicted value), the data is normally distributed and does not show any abnormal patterns. In addition to that, this is checked with a Q-Q plot for every independent variable (IV). No violations were observed. To check whether the assumption of homoscedasticity is met, a scatterplot of residual values versus the predicted value is used. The variation in the residuals is equally spread and there is no pattern identified; indicating that there are no major violations in the homoscedasticity. Subsequently, the Pearson correlations are used to check for multicollinearity (see Table 3). There are some indications for violation of this assumption, as there are some high correlations represented. Despite this, only two correlations are crossing the threshold of $r = 0.7$, which might be a sign of multicollinearity. Another way to check for this assumption, is the variance inflation factor (VIF). It is established that there are no major violations in multicollinearity either, as none of the independent variables have a calculated VIF that exceeds the value of 10. Lastly, because of the used research design, the independence of the residuals can be assumed.

For analyzing the data, standard multiple regression is used for prediction and contribution of the IV's (the eight HF dimensions) on the DV (the risk of ADHD). All the IV's are simultaneously added via the enter method to check whether the model as an entity is significant. Also, the separate IV's are checked for significance and for their semi-partial squared

correlation, to determine the proportion of the variance of the severity of ADHD that is explained by their unique contribution. Furthermore, the Pearson correlation coefficient is used for identifying associations and multicollinearity between the dimensions of HF and the DV.

Results

Descriptive statistics

Table 1 summarizes the mean and standard deviation for age, the HF constructs, and the ASRS-S score. ‘Deep and intense focus’ does have the highest value of the mean, ‘awareness of the self’ does have the lowest.

Table 1

Descriptive Statistics Age, HF Constructs and ASRS

	Mean	*SD*
Age	21.6	4.04
AW	3.31	.863
AT	3.53	.812
AS	3.02	.831
NF	3.36	.758
DIF	3.95	.722
SIT	3.34	.553
AF	3.32	.863
PC	3.65	.688

ASRS	2.11	.638

Note. n=320, AW: ‘reduced awareness of the world’; AT: ‘reduced awareness of time’; AS ‘reduced awareness of the self; NF: ‘narrow focus’; DF: ‘deep and intense focus’; ST: ‘stopping and initiating other things’; AF: ‘automatic focus’; PC: ‘prolonged concentration’

Standard multiple regression analysis

For assessing the hypothesis, a standard multiple regression using the enter method, is utilized to examine to which extent the severity of ADHD can be predicted based on eight constructs of the HF construct. When adding the IV’s simultaneously, the model of all the predictors together do explain a significant amount of variance of the ADHD score. A significant regression equation is found ($F(8,311) = 16,724$, $p < .000$), with an R^2 of 0.301, R^2 *Adjusted* = .283. The unstandardized beta, the significance level, the semi-partial correlation and the semi-partial correlation squared for this analysis are displayed in Table 2. Table 2 reveals that the majority of the dimensions is not significant. Additionally, certain dimensions show a negative unstandardized beta. The dimension ‘automatic focus’ appears to have the highest semi-partial correlation squared. Even so, the belonging fitted regression equation follows 2.231 - 0.056 (world awareness) + 0.117 (time awareness) + 0.268 (self-awareness) + 0.051 (narrow focus) + 0.34 (deep and intense focus) + 0.127 (stopping and initiating other things) - 0.412 (automatic focus) - 0.142 (prolonged concentration). Following, it can be stated that hypothesis 1 is confirmed: all HF dimensions together are significant predictors of the DV.

For exploratory reasons, the dimensions of HF can be analyzed separately. The provided data in table 2 shows that the dimensions ‘awareness of the self’, ‘awareness of the time’ and ‘automatic focus’ do predict a significant amount of the DV; these factors can be used to draw

conclusions confidently. The dimensions ‘Awareness of time’, ‘awareness of the self’ and ‘automatic focus’ are significant predictors for the risk of ADHD. As shown in table 2, the dimension ‘automatic focus’ has a negative value for the unstandardized beta. To establish which of those dimensions have the greatest proportion of unique variance explained in the DV, the semi-partial squared correlation is taken into consideration, as shown in Table 2. The construct ‘automatic focus’ has the highest proportion of unique variance explained (16,4 percent), this depicts that this IV explains the most unique variance of the model, however it is important to emphasize that this dimension has a negative coefficient.

Table 2

Unstandardized beta, semi-partial correlation and semi-partial correlation squared

HF construct	$B_{unstandardized}$	*Sig.*	*sr*	sr^2
AW	-0.056	0.372	-0.037	0.001
AT	0.117	0.042	0,090	0,008
AS	0.268	0.000	0.224	0,050
NF	0.051	0.364	0.034	0,001
DF	0.034	0.625	0.027	0.001
ST	0.127	0.074	0,102	0,010
AF	-0.412	0.000	-0.405	0,164
PC	-0.142	0.051	-0,093	0.009

Note. n=320, AW: ‘reduced awareness of the world’; AT: ‘reduced awareness of time’; AS ‘reduced awareness of the self; NF: ‘narrow focus’; DF: ‘deep and intense focus’; ST: ‘stopping and initiating other things’; AF: ‘automatic focus’; PC: ‘prolonged concentration’

Pearson correlation coefficients

Table 3 represents the in-between relationships between the DV, the eight IV’s and the mutual associations of the IV’s. This table reflects three constructs which are significantly correlating with the ASRS-S: ‘awareness of the self’, ‘automatic focus’ and ‘prolonged concentration’. Values < 0.29 are identified as ‘low correlation’, values between 0.30 and 0.49 as ‘moderate correlations’. It can be stated that there is found one moderate correlation with the ASRS-S (‘automatic focus’), which has a negative coefficient. Further, two low correlations were found with the ASRS-S: a positive one (‘awareness of the self’) and a negative one (‘prolonged concentration’).

Table 3

Pearson Correlations of the ASRS screener (IV) and the HF constructs (IV’s)

	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. AW	-								
2. AT	0.713**	-							
3. AS	0.680**	0.618**	-						
4. NF	0.595**	0.504**	0.488*	-					
5. DF	0.723**	0.629**	0.572**	0.615**	-				

6. ST	0.519**	0.525**	0.540**	0.447**	0.501**	-			
7. AF	0.486**	0.411**	0.442**	0.536**	0.554**	0.401**	-		
8. PC	0.655**	0.610**	0.586**	0.641**	0.681**	0.553**	0.605**	-	
9 ASRS	0.017	0.100	0.164**	-0.063	-0.044	0.075	-0.374**	-0.119*	-

Note. n=320,**. Correlation is significant at the 0.01 level (2-tailed), *. Correlation is significant at the 0.05 level (2-tailed). AW: 'reduced awareness of the world'; AT: 'reduced awareness of time'; AS 'reduced awareness of the self; NF: 'narrow focus'; DF: 'deep and intense focus'; ST: 'stopping and initiating other things'; AF: 'automatic focus'; PC: 'prolonged concentration'.

Discussion

In this exploratory study, we look at eight dimensions of HF, together and separately, and their predictive value on the risk of ADHD. Thereby, we try to provide more support for the core HF questionnaire and the included dimensions. Additionally, the concept of HF can step by step be developed towards a more well-established concept with empirical evidence. In line with prior literature (Sklar, 2013; Ozel-Kizil et al., 2016; Hupfeld et al., 2018; Grotewiel et al., 2022), we found that all HF dimensions together have the ability to predict the risk of ADHD. Our hypothesis stated that the eight HF dimensions together do explain a significant amount of variance for the risk of ADHD and we can establish that this one is supported. Our research has an exploratory nature, which allows us to analyze the relevance of the dimensions on their own. So, when taking a closer look at the dimensions separately, the majority does not provide sufficient predictive value for the risk of ADHD. Although, the dimensions 'awareness of the self' and 'awareness of time' do emerge as adequate predictors individually. This illustrates that

less awareness of the self and less awareness of time during a focus episode, can possibly indicate a higher risk of ADHD. Furthermore, the dimension ‘automatic focus’ also came out as a sufficient predictor, but in a reversed way. So, experiencing more automatic focus during a focus period, is rather indicating a decreased risk of ADHD. This dimension showed a relatively strong predictive value and additionally a strong negative relation with the risk of ADHD. Despite there being no hypothesis regarding the direction of the dimensions, such a strong negative predictor was contrary to expectation, as prior research The dimension ‘prolonged concentration’ is negatively associated with the risk of ADHD as well. This tells us that more prolonged concentration, indicates a lower risk of ADHD, but simultaneously, when having a higher risk of ADHD, there are perhaps lower levels of prolonged concentration.

In the first questionnaire concerning HF (Ozel-Kizil et al, 2016), the research findings stated that HF can be seen as a separate dimension of ADHD, as HF is more prevalent in adults with higher ADHD symptoms compared to healthy controls. This is similar to our findings, but it is important to highlight that Ozel-Kizil et al. (2016) were mainly focused on the negative consequences of HF, which perhaps explains the association between HF and the risk of ADHD. Our dimension ‘awareness of time’ came out as a sufficient predictor for the risk of ADHD, which is in line with the outcome of ‘impaired time management’ dimension in the study of Ozel-Kizil et al. (2016). Despite the fact that we tried to distinguish our dimensions from their consequences, this result indicates that it is uncertain whether it was really distinguished. As it can be hard to distinguish HF from its situational aspects and from the consequences, further research is needed. Subsequently, the outcomes of ‘automatic focus’ and ‘prolonged concentration’ being negative predictors for the risk of ADHD, can perhaps be explained by

these dimensions being more positive consequences of HF. Further research can explore the consequences of certain dimensions more in depth.

Grotewiel et al. (2021) found support for some negative consequences of HF. ‘Losing track of time’ and ‘difficulty switching tasks’ are similar to our dimensions ‘awareness of time’ and ‘stopping and initiating other things’. We found support for ‘awareness of time’ as a positive predictor of the risk of ADHD. This illustrates that this certain dimension might function as a negative consequence of HF.

A possible explanation for some dimensions being negatively associated with the risk of ADHD can be that ADHD, besides the occurrence of HF episodes, is still characterized by impairment in concentration and focusing. As our research is preliminary, there is a high chance that certain dimensions are not specifically HF based, but rather associated with more regular concentration, which is generally impaired in ADHD. Additionally, for people filling in the questionnaire, it might be hard to distinguish regular, increased focus from HF. HF is still a subjective experience and there is no well-established working definition of HF to help people make this distinction between normal focus and HF. For example, the question: ‘there are moments in which my attention is completely captured or caught up by something’ points more towards a regular focus experience, as most people get caught up in something occasionally. For improving the questionnaire in the future, it is important to keep in mind that more neutral formulated questions can probably elicit responses regarding regular focus, so this makes it more complicated to make a statement about HF.

As mentioned before, the occurrence of certain HF behaviors can possibly misdirect an accurate ADHD diagnosis, considering the main distractibility symptom of ADHD. When more sufficient awareness is created about the fact that certain HF behaviors can predict risk of ADHD

('less awareness of the self' and 'less awareness of time' during focus episodes), the sensibility and specificity of the diagnosis process can possibly be improved by this in the future.

Strengths and limitations

As we examined eight different aspects of HF and used four or six questions per construct, the content validity of our research can be considered sufficient. The conducted sample size consisted of 368 participants, and therefore the power of the study was sufficiently large as well. Additionally, strict exclusion criteria are used to optimize the data and it is possible to control for several variables. This is important in the light of reducing the influence of confounding variables, such as age, gender and educational status. In the current research, no control variables were used, but this can be considered in future studies to improve the validity.

A conceptual reason for the unexpected findings possibly depends on the repetitive design of the questionnaire, especially for laypersons. The eight dimensions of HF are measured through 46 items. As a participant, who does not have access to the information regarding the exact topic of the research, the items appear to be very much alike. As those participants experience the questionnaire as lengthy and repetitive, it can cause them to fill in the answers recklessly, without conscious consideration. There is some attempt to counter this, using the validity control questions and the questions were randomized to prevent order bias, but we still cannot completely exclude the chance that people have rushed through it, which comprises the external validity. Further, some participants mentioned that the questionnaire made them feel like they were constantly checked about consistency in their responses, which probably caused them to prioritize consistency above honesty. This might affect the reliability and validity of the research.

Additionally, there is not much differentiation in the completion of education and therefore our sample is probably not an accurate reflection of the society. A potential reason for the homogeneous sample is the fact that our study took part in the SONA pool, which is only accessible to Psychology students. In addition to that, those students are obligated to gain a certain number of points through this pool, so a strong external motivation is involved to complete our questionnaire. Another source of participants is the Paid Participants Pool; this one is not limited to Psychology students only, although this pool is rather known amongst Psychology students as it mainly contains research in this discipline. Hence, due to the homogeneous sample, insufficient population validity and so external validity are established. Regardless of the fact that Psychology students are not a valid reflection of the entire population, there is yet another factor concerning this group that affects validity as well. Psychology students are presumably more capable of introspection, which can lead to responses that are more thought out than the average individual would do. There can be applied statistical control for educational level, which is advised for further research. Although, when the range of education stays very narrow, statistical control will not solve this restriction. This can be improved by random sampling, explicitly in environments which are not predominantly occupied by higher educational groups or younger age groups.

Also, further studies can look at to which extent our current dimensions are more prone to be positive or negative consequences of HF, as negative consequences of HF are tending to be stronger associated with HF. Some of our current dimensions can possibly be linked to potential positive or negative consequences of HF, but it is important to get clear to what extent this is the case. There is no empirical evidence regarding which dimensions of HF are more prone to be

interpreted as negative or positive consequences yet, so this needs to be clarified first. Here, it is important to consider the length of the questionnaire; simply adding extra items is not desirable. Lastly, our study was limited to people above eighteen years old. Research concerning HF and ADHD within younger children is limited and would be interesting to elaborate on.

Conclusion

Conclusively, our study expands the scarce knowledge regarding HF and the developing the core HF questionnaire, containing eight HF constructs. All dimensions of HF together can be used as a sufficient predictor for the risk of ADHD. Our findings indicate that the dimensions ‘awareness of the self’ and ‘awareness of time’ are positive predictors, so decreased awareness of the self and time, means an increased risk of ADHD. ‘Automatic focus’ came out as a negative predictor, which indicates that more automatic focus, means decreased ADHD risk. Within clinical settings, a certain awareness must be created about the fact that HF episodes do not exclude ADHD symptomatology. In future research, the preliminary dimensions need to be further tested to establish them empirically. Also, more investigation is needed to clarify the positive and negative consequences of HF, as negative consequences of HF seem to be stronger associated with a higher risk of ADHD.

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