

Hyperfocus and cognitive motivators in an academic setting

Dharmil Gandhi

S4001028

Department of Psychology, University of Groningen

PSB3E-BT15: Bachelor Thesis

Group number- 18

Supervisor: Dr. Miguel Garcia Pimenta & Mrs. Angèle

Picco

October 30, 2022

Abstract

There is a dearth of research on Hyperfocus in healthy participants. Hyperfocus is when an individual is wholly engrossed in their task and completely "tunes out" their surroundings. Hyperfocus can be defined as increased attention and focus due to heightened motivation toward a task or activity. This research paper investigates the effect of cognitive motivators- (intrinsic motivation to know, epistemic curiosity - joyous exploration and deprivation sensitivity, and need for cognition) on the frequency of Hyperfocus in university students in an academic scenario. 375 first-year university students were recruited through convenience sampling and given an online survey to complete. The results showed that intrinsic motivation and deprivation sensitivity significantly increase the frequency of Hyperfocus in an academic context. However, joyous exploration and the need for cognition did not significantly increase the frequency of hyperfocus. Moreover, the results showed that all the cognitive motivators used in the study were positively and significantly correlated. The study concluded that individuals with high intrinsic motivation and deprivation sensitivity would have a higher frequency of hyperfocus experiences in an academic context.

Hyperfocus and cognitive motivators in an academic setting

Hyperfocus is considered an "extraordinary gift" by many individuals with attention deficit hyperactivity disorder (ADHD) (ADDitude Editors, 2021). Some individuals with ADHD can channel their Hyperfocus on something productive, for example, in occupational (work) or academic (school) contexts. Hyperfocus, as an example, is when a child is completely engrossed in the video game and does not seem to pay attention to any stimuli nearby. The phenomenon of Hyperfocus is usually mentioned in association with ADHD (Sklar, 2013; Ozel-Kizil et al., 2016), autism (Isomura et al., 2015), and schizophrenia (Gray et al., 2014; Hahn et al., 2016). However, the operational definition was construed using four features of Hyperfocus. Firstly, Hyperfocus is induced by task engagement. Secondly, Hyperfocus is characterized by an intense state of sustained or selective attention. Thirdly, during a hyperfocus state, there is a diminished perception of non-task-relevant stimuli. Lastly, during a hyperfocus state, task performance improves (Ashinoff, 2019).

Research explains that the states of Hyperfocus are often triggered due to tasks perceived as "rewarding," "challenging," "interactive," and/or "novel." The task qualities imply that the task is perceived to be rewarding with a motivational salience. Unfortunately, a dearth of research is based on Hyperfocus and other cognitive motivators. A cognitive motivator is the motivation or drive to know or the thirst for knowledge. These cognitive motivators can help us to understand whether heightened motivation can help increase the frequency of experiencing hyperfocus states. This research paper will investigate the effect of three cognitive motivators – Intrinsic motivation, need for cognition, and Epistemic curiosity. The association between Hyperfocus and cognitive motivators should be explored because it can fill the literature gap and help us understand the potential reasons for experiencing Hyperfocus.

Hyperfocus

In older research, Hyperfocus was defined as a clinical phenomenon of "locking on" to a task in patients with ADHD who have difficulty shifting their attention from one subject to another, especially if the subject is about their interests (Conner, 1994). However, the definition of Hyperfocus was recently updated to a phenomenon that reflects one's complete absorption in a task to a point where a person appears to ignore or "tune out" everything else completely. (Ashinoff, 2019). The latest definition does not specify that individuals with ADHD only experience Hyperfocus. Moreover, Groen et al. (2020) showed that 83% of healthy people experience Hyperfocus in their everyday life. Altogether, Hyperfocus is more commonly experienced by individuals with ADHD but experienced by the healthy population. Although people with ADHD face difficulty in shifting their attention from tasks which increases the frequency of experiencing the state of Hyperfocus (Ozel-Kizil et al., 2016), Hyperfocus is not an official symptom of ADHD according to the DSM-5. Moreover, Hyperfocus is explained through the use of external positive reinforcement (Swan, 2021), frequent/ intense rewards (games), and novelty (Banaschewski et al., 2018; Barkley et al., 1997). Therefore, different types of cognitive motivators will be explored in a healthy population to understand the impact of specific individual differences which influences the frequency of Hyperfocus.

In some studies, Hyperfocus is also referred to as "flow." The criteria of flow and Hyperfocus are similar in describing the phenomenon; however, they are distinct experiences (Ashinoff, 2019). Flow is a terminology widely used in positive psychology, while Hyperfocus is used in psychiatric settings. Research shows that Hyperfocus may be a particular type of "deep flow" characterized by detachment from the environment more extreme than is experienced in normal or "shallow" flow states (Grotewiel et al., 2022). Since Hyperfocus is considered an extreme state of flow, we can assume that Hyperfocus and flow

are similar constructs of different intensities. Therefore, some research from flow would be used in the research to assume Hyperfocus. There is a good amount of research devoted to flow and several cognitive motivators. For example, considerable research shows that flow is highly associated with intrinsic motivation and enjoyment (Csikszentmihalyi, 1990). Moreover, research shows that individuals with a higher need for cognition have higher levels of focused attention and are more likely to experience flow (Li et al., 2004). Schutte et al. (2020) showed that individuals with higher levels of curiosity are associated with more flow experiences.

Intrinsic motivation

Intrinsic motivation refers to doing an activity for its inherent satisfaction rather than for some external rewards or incentives. When intrinsically motivated, a person is driven to act for the fun or challenge entailed rather than because of external products, pressures, or rewards (Ryan and Deci, 1985, 2000). There are three types of intrinsic motivation, which are intrinsic motivation to know (IM- to know), intrinsic motivation towards accomplishments (IM- to accomplish), and intrinsic motivation to experience stimulation (IM- to experience stimulation) (Vallerand et al., 1993). IM- to know is when one receives satisfaction while learning or understanding something new. IM- to accomplish is when one engages in an activity to get satisfaction when one accomplishes or creates something. IM- experience stimulation is when one experiences stimulating sensations while engaging in an activity or task.

The different types of intrinsic motivation include a wide range of activities that are internally rewarding, for example, a student reading a book for the pleasure of learning something new. IM- to know can be defined as performing an activity for the pleasure and satisfaction one experiences while learning, exploring, or trying to understand something new

(Vallerand et al., 1993). Therefore, IM- to know explains the drive and thirst for knowledge seeking. As Hyperfocus is a state of increased attention and focus due to heightened motivation toward a task or activity (Hupfeld et al., 2018), it can be assumed that an individual who is highly intrinsically motivated toward an activity or task can increase the frequency of the state of Hyperfocus. As a result, a potential association between intrinsic motivation and the frequency of Hyperfocus will be explored in the research.

Epistemic curiosity

Epistemic curiosity can be defined as a "desire for knowledge that motivates individuals to learn new ideas, eliminate information-gap and solve intellectual problems" (Litman, 2008). For example, when someone is curious about a topic or activity, they tend to pursue the answer and eliminate the knowledge gap instead of the mind wandering off to another topic. Since Hyperfocus is also a state of intense focus, high curiosity could be one of the reasons making it easier for an individual to experience it. Curiosity is a multidimensional scale, which are joyous exploration, deprivation sensitivity, stress tolerance, social curiosity, and thrill-seeking. Joyous exploration and deprivation sensitivity will be used as these dimensions correlate the strongest with epistemic curiosity (Kashdan et al., 2018). On the one hand, joyous exploration is the pleasurable experience of finding topics and activities intriguing, for example, the love of learning or fascination with activities and topics. On the other hand, deprivation sensitivity is the anxiety and frustration of being aware of the information one does not know; one wants to know and devotes considerable effort to uncovering (Kashdan et al., 2018).

It is well known that when an individual is intrinsically motivated toward a task or activity, they are more likely to be curious about it (Berlyne, 1960; Ryan & Deci, 2000). Similarly, it can be assumed that an individual with high joyous exploration and deprivation

sensitivity can enter the hyperfocus state when highly motivated to eliminate the knowledge gap. Since Hyperfocus is a state of heightened attention, high levels of joyous exploration and deprivation sensitivity can predict the frequency of hyperfocus experiences. Therefore, the research will also explore the potential association between the frequency of Hyperfocus and epistemic curiosity- joyous exploration and deprivation sensitivity.

Need for cognition

Lastly, the need for cognition, a personality trait, was defined as "an individual's tendency to engage in and enjoy effortful cognitive activity" (Cacioppo et al., 1982, 1996). People with a high need for cognition seek out and reflect on the information to make sense of the stimuli and events. Additionally, a high need for cognition reflects that individuals will have a more positive attitude toward situations requiring reasoning and problem-solving and respond more substantively to such situations (Coelho et al., 2022). Curiosity and the need for cognition have many similarities; it is also shown that an individual with a high need for cognition would be more curious about these tasks and activities (Olson et al., 1984). However, one of the differences is that epistemic curiosity is the desire to obtain new knowledge to stimulate positive feelings of intellectual interest and reduce undesirable states of informational deprivation. At the same time, the need for cognition refers to the individual differences in the motivation to engage in and enjoy effortful cognitive tasks (Strobel et al., 2014). Both the need for cognition and epistemic curiosity can increase the frequency of Hyperfocus because both involve internal rewards through the satisfaction of engaging in rewarding activities. Therefore, when the need for cognition is high, an individual will tend to be more attentive, which can predict the frequency of experiencing Hyperfocus.

Many studies show a link between the cognitive motivators investigated in the study. Olson et al. showed that individuals with a high need for cognition would have higher

curiosity levels in seven measures. Moreover, Thompson et al. (1993) showed that the need for cognition involves intrinsic motivation. Thus, people with a high need for cognition will have higher intrinsic motivation for effortful cognitive processes. Similarly, curiosity can be interpreted as part of intrinsic motivation (Ryan & Deci, 2000). Therefore, if an individual has high levels of intrinsic motivation, they will also have high levels of curiosity. The research showing the association between cognitive motivators is old, using different materials. However, this study will use appropriate and updated measures to quantify the variables measured.

The research will explore the association between the frequency of hyperfocus experiences and motivating cognitive constructs to comprehend which factors can predict the frequency of experiencing a hyperfocus state. Consequently, this research paper will aim to explore the following two research questions:

1. To what extent do the cognitive motivators: intrinsic motivation, need for cognition and epistemic curiosity predict the frequency of hyperfocus experiences in students in an academic scenario?
2. To what extent are the cognitive motivators associated with each other?

Five hypotheses will be explored in this research study. Firstly, it is hypothesized that individuals with high intrinsic motivation would have a higher frequency of hyperfocus experiences. Second, individuals with a high need for cognition would have a higher frequency of hyperfocus experiences. Thirdly, individuals with higher levels of joyous exploration will have a higher frequency of hyperfocus experiences. Fourthly, individuals with higher levels of deprivation sensitivity will have a higher frequency of hyperfocus experiences. The first four hypotheses are based on the first research question. The last hypothesis, which explores the secondary research question, is that there would be a positive association between cognitive motivators.

A lack of research is present that determines the association between Hyperfocus and the potential individual differences, which will be explained in this study. Moreover, the previous research on Hyperfocus did not measure “hyperfocus in school” when studied on a student sample. Similarly, studies that measured “hyperfocus in school” did not include a student sample in their research. Therefore, this research will help us to understand how Hyperfocus in school is experienced in a population of graduate-level students, alongside the association of cognitive motivators.

Methods

Participants

A convenience sample of bachelor students was gathered by advertising through social media, hanging flyers around the university, and SONA. Participants were selected based on the inclusionary criteria: students in the first, second, or third year of the BSc of Psychology at the University of Groningen. Therefore, students of Master’s and other bachelor’s courses were part of the exclusionary criteria. The first-year students were only gathered using the SONA participants pool. The second and third-year students were collected using social networks (such as WhatsApp) and fliers around the campus. Of the 394 participants who initially filled out the survey, 19 participants (4.82%) were removed because they did not meet the criteria, as 12 participants (3.05%) did not complete the entire questionnaire, six participants (1.52%) finished the survey in under ten minutes, and one participant (0.25%) failed to answer the bogus question. Therefore, our final sample consisted of 375 participants.

Moreover, the sample consisted of 88 male participants (23.57%), 258 female participants (76.0%), and two participants (0.53%) who preferred not to say their biologically assigned sex at birth. The average age of the participants was 19.76 years ($SD = 2.10$), while the minimum age of a participant was 17 years, and the maximum age was 35 years. Most of

the participants in our sample were Dutch (49.87%). Also, 84 participants were German (22.4%), and 104 had a different nationality (27.73%). 88% of the participants had completed the upper secondary level of education (n= 330). All participants in the first year of their bachelor's degree (SONA participant pool) received SONA credits as an incentive. However, all other 10 participants, such as second and third-year students, were rewarded with an incentive of 1.5 euros.

Materials/Measures

The Hyperfocus in School Scale was used to measure the frequency of Hyperfocus in the academic context. This questionnaire is a 12-item subscale of the Adult Hyperfocus Questionnaire (AHQ; Hupfeld et al., 2019) centered around Hyperfocus in the context of school. Some examples of statements used in this questionnaire included ("Completely losing track of time while doing work for the class.", "Not noticing the world around you [e.g. not realizing if someone calls your name or if your phone buzzes] if you're working on homework or studying."). The Hyperfocus in School Scale originally made use of a six-point Likert scale ranging from 'Never' to 'Daily', in the adapted version a six-point Likert scale is used however it ranges from 'Never' to 'Always/Daily'. Further differences relative to the original included a timeframe in the Likert scale, such as 'Rarely / 1-2 times every 6 months', 'Sometimes 1-2 times per month', 'Often / Once a week', and 'Very often / 2-3 times a week'. The purpose of this modification was to ensure results of the AHQ were comparable with other outcome measures in the study. The scores in this scale were computed by calculating the sum of all the items present for a total score of 72. The original questionnaire had an additional instruction for participants to identify their favorite course and keep this in mind when answering the questionnaire ("What is your favorite course that you have taken so far in college? This could be a class that you are currently taking."). In our study, we have

omitted this to allow participants to generalize the questions to all university-related work. In the current sample, this scale had a Cronbach's alpha of .87.

The Need for Cognition-6 (NCS-6, Coelho et al., 2020) questionnaire measured the amount of enjoyment people get from engaging in cognitively challenging activities. This is an 11 adapted version of the original Need for Cognition scale. The NCS-6 questionnaire is a six-item survey that uses a five-point Likert scale ranging from 1 (extremely uncharacteristic) to 5 (extremely characteristic). No changes were made to the original NCS-6 when it was used in our survey. The survey contained six statements about Need for Cognition (“Would prefer complex to simple problems.”, “I really enjoy a task that involves coming up with new solutions to problems.”); two of which were reverse-coded (“Thinking is not my idea of fun.”, “I would rather do something that requires little thought than something that is sure to challenge my thinking abilities.”). This scale was calculated by finding the sum of scores across the six items. The NCS-6 in the present sample had a Cronbach's alpha of .74.

The Five-Dimensional Curiosity Scale (5DC; Kashdan et al., 2018) measured the multidimensional construct of curiosity as well as concepts that are related to curiosity, such as openness to experience. This scale consisted of 25 questions and used a seven-point Likert scale from 1 (does not describe me at all) to 7 (completely describes me). The subscales of the 5DC are Joyous Exploration, Deprivation Sensitivity, Stress Tolerance, Social Curiosity, and ThrillSeeking. All of these subscales contained five items. Moreover, the Stress Tolerance subscale was entirely reverse-coded. The score of each subscale was calculated by finding the average of each dimension. For the present study, the subscales “Deprivation Sensitivity” and “Joyous Exploration” were used to assess the construct “Epistemic Curiosity.” No changes were made to the original scale in the survey of the present study. Statements used for the 5DC Deprivation Sensitivity subscale included (“Thinking about solutions to difficult conceptual problems can keep me awake at night.”, “I work relentlessly

at problems that I feel must be solved.”). Some statements used for the 5DC Joyous Exploration subscale were (“I view challenging situations as an opportunity to grow and learn.”, “I find it fascinating to learn new information.”). Overall, in the sample the 5DC Cronbach’s alpha for the Deprivation Sensitivity subscale was .83, while for Joyous Exploration the Cronbach’s alpha was .78.

The Academic Motivation Scale (AMS; Vallerand et al., 1992) was used to measure the motivation of students towards learning. The questionnaire consists of 28 items, and it makes use of a seven-point Likert scale ranging from 1 (does not correspond at all) to 7 (corresponds exactly). Additionally, this questionnaire consisted of seven subscales of motivation, which had four items each: Amotivation, Intrinsic Motivation to Know, Intrinsic Motivation toward Accomplishment, Intrinsic Motivation to Experience Stimulation, Extrinsic Motivation Identified, Extrinsic Motivation Introjected and Extrinsic Motivation External Regulation. For the present study, the intrinsic motivation subscale “Intrinsic Motivation to Know” was used to investigate academic intrinsic motivation. The scale has been adapted to use the term “college/university” as opposed to “school” which was used in the original scale. Participants needed to answer to what extent the statement corresponds to the reason they went to college/university. The scores of this survey were calculated by finding the average of each subscale.

Some examples of statements for the Intrinsic Motivation to Know subscale include: "Because I experience pleasure and satisfaction while learning new things." and "Because my studies allow me to continue to learn about many things that interest me." For Intrinsic Motivation toward Accomplishment, some of the questions are as follows: “For the pleasure that I experience while surpassing myself in my studies.” and “Because high school allows me to experience personal satisfaction in my quest for excellence in my studies.” Some examples of Intrinsic Motivation to Experience Stimulation were: “For the pleasure that I

experience when I am taken by discussions with interesting teachers.” and “Because for me, college is fun.” The Cronbach’s Alpha of the Intrinsic Motivation to Know subscale is .84.

Procedure

Participants were asked to complete a survey, which took approximately 20 minutes. Each participant was provided with informed consent before the start of the study. The informed consent informed the participants about the incentives they would receive after completing the survey. In addition, the participants were well informed about their anonymous and confidential data. Participants took the survey online (made using Qualtrics) through the barcode provided in the flyers. At the same time, first-year psychology students could access this study in SONA through a link provided to them. Furthermore, the participants were also asked to fill in their student numbers to have access to their academic grades. The study was only conducted after receiving approval from the ethical committee regarding the whole study.

The survey created uses seven questionnaires that cover academic motivation and underlying factors that can contribute to hyperfocus and flow states. The questionnaires present in the survey include the Hyperfocus in School Scale of the AHQ (Hupfeld et al., 2019), the Dispositional Flow Scale (Jackson et al., 2008), the Need for Cognition-6 scale (Coelho et al., 2020), the Utrecht Work Engagement Scale (Seppälä et al., 2009), the Five Dimensional Curiosity Scale (Kashdan et al., 2018), the Academic Motivation Scale (Vallerand et al., 1992) and the Adult ADHD Self Report Scale v1.1 (Kessler et al., 2005). For the present study, we focus on the Hyperfocus in the School Scale of the AHQ, the Need for Cognition scale, the 5- Dimensional Curiosity Scale, and the Academic Motivation Scale.

The survey consists of several blocks to collect demographic information, education information, Five-Dimensional Curiosity scale, Need for Cognition, Academic Motivation, Utrecht Work Engagement, School Hyperfocus scale of the AHQ, Dispositional Flow Scale

Short, Adult ADHD Self Report Scale and medical and personal information, and the measures of the predictor variables and the outcome measures. Two main randomizations occur in the 14 questionnaire; the first randomization will alternate the order in which the predictor variable measures are introduced to participants with the Scales for Need for Cognition, Academic Motivation, and the Five-Dimensional Curiosity Scale. The second randomization occurs for the outcome measures; participants will be presented with the Utrecht Work-Engagement Scale, the Hyperfocus in School Scale of the AHQ, and the Dispositional Flow Scale. It was done to avoid all the participants having the same sequence of questions and reduce biases.

Design

This study used two types of research designs. To test our first hypothesis, we used a correlational cross-sectional design to investigate if the three motivational factors, together and separately, had a significant effect on the frequency of experiencing a hyperfocus state. To test our second hypothesis, we implemented a correlational design to investigate if the three individual motivational factors had significant correlations with each other. This quantitative study served to explore the proposed association of the three motivational independent variables (IV) with the dependent variable (DV) regarding the frequency of experiencing a state of Hyperfocus.

Our independent variables (IV) consisted of the three cognitive traits (need for cognition, epistemic curiosity, and intrinsic motivation), all using their respective questionnaires. For the sake of analysis, epistemic curiosity was divided into two separate variables: Joyous Exploration and Deprivation Sensitivity. The dependent variable (DV), school hyperfocus, was collected in the same way as the IVS, namely with its respective questionnaire. Techniques for data analysis consisted of Pearson's coefficient, multiple regression analysis, partial correlations, and ANOVA outputs.

Results

Descriptive statistics

Linearity, normality, and outlier checks were computed to investigate any potential violation of assumptions for the Pearson correlations calculated in the main analysis. Additionally, linearity, homoscedasticity, normality, multicollinearity, and outlier checks were used to test the assumptions for the multiple linear regression. Since the research design did not use a repeated measure, the independence assumption was not violated. A scatter plot was computed using the dependent and independent variables to check for linearity assumption. The graph showed that linearity was present, and the assumption was not violated. Normality was checked using histogram and PP plots from the residual values. The histogram and PP plot showed normality without skewness; thus, the assumption was not violated. A scatterplot of residual values against the dependent variable was computed to check for homoscedasticity, which showed that the scatter points were scattered equally on the graph. Additionally, a box plot was computed for the variables, and no outliers were found. All the independent variables reported VIF values under the cut-off of 10; thus, the multicollinearity assumption is also not violated. None of the assumptions were violated during the analysis; thus, the data is safe to interpret.

A preliminary descriptive analysis is conducted to summarize the main features of the data collected. The school hyperfocus variable was measured on a 7-point Likert scale where one indicated "never." The mean of the hyperfocus variable is 3.11 ($SD = 0.84$). Therefore, on average, participants selected the "sometimes / 1-2 times per month" option to answer for Hyperfocus. The highest mean was reported for Intrinsic motivation to know ($M = 5.65$, $SD = 0.87$), where five represented "corresponds enough." Moreover, the mean need for cognition was 3.58 ($SD = 0.63$), corresponding to "uncertain."

Table 1

Means, Standard Deviations, and Correlations between the variables studied.

	Mean	SD	1	2	3	4	5
1. Hyperfocus in School	3.107	0.840	-	0.224**	0.189**	0.452**	0.275**
2. Need for Cognition	3.578	0.633	-	-	0.629*	0.383*	0.422*
3. Joyous exploration	5.116	0.890	-	-	-	0.372*	0.520*
4. Deprivation sensitivity	4.347	1.240	-	-	-	-	0.297*
5. Intrinsic Motivation- to know	5.650	0.870	-	-	-	-	-

Note: N = 375.

*P ≤ 0.01

**P ≤ 0.001

Hypothesis testing

The study aimed to understand whether cognitive motivators (Intrinsic motivation, epistemic curiosity, and need for cognition) predict the frequency of Hyperfocus in an academic scenario. Firstly, it is hypothesized that individuals with high intrinsic motivation would have a higher frequency of hyperfocus experiences. Second, individuals with a high need for cognition would have a higher frequency of hyperfocus experiences. Thirdly, individuals with higher levels of joyous exploration will have a higher frequency of hyperfocus experiences. Fourthly, individuals with higher levels of deprivation sensitivity

will have a higher frequency of hyperfocus experiences. Lastly, there would be a significant positive association between cognitive motivators.

Multiple regression was conducted where Hyperfocus, the dependent variable, was regressed on the cognitive motivators (Intrinsic motivation, epistemic curiosity, and need for cognition). Epistemic curiosity was measured on two dimensions (Joyous exploration and Deprivation sensitivity) of the 5-dimension scale. Intrinsic motivation- to know was used to measure intrinsic motivation. The results showed that the multiple regression model was significant and explained 23% of the variance between the hyperfocus and cognitive motivators ($R^2 = 0.230$, $F(4, 370) = 27.629$, $p < 0.001$). As shown in table 2, deprivation sensitivity ($p = <0.001$) and intrinsic motivation ($p = 0.001$) reported significant coefficients. The results show that for every one-point increase in the deprivation sensitivity, the hyperfocus scale would increase by 0.281. Similarly, for every one-point increase in intrinsic motivation, the hyperfocus variable would increase by 0.172. Interestingly, the need for cognition and joyous exploration variables were reported in nonsignificant coefficients. Moreover, a negative coefficient was reported for joyous exploration at -0.081 ($p = 0.179$).

Partial and Semi-partial correlations were computed as well. Partial correlation showed that deprivation sensitivity correlated with Hyperfocus reported in a moderate positive correlation when controlled for the other variables. ($r = 0.392$, $p < 0.005$). However, a partial correlation between joyous exploration and Hyperfocus was reported as a weak negative correlation. Thus, when controlled for the other predictors, joyous exploration was negatively correlated with Hyperfocus with a weak correlation ($r = -0.070$, $p < 0.005$). Semi-partial correlations were calculated to interpret the unique variance explained by each predictor. The strongest predictor with unique variance was ($r = 0.374$, $p < 0.005$). Similar to the partial correlation of joyous exploration, the semi-partial correlation with Hyperfocus was also a weak negative correlation ($r = -0.061$, $p < 0.005$). As reported in Table 2, the squared

semi-partial correlations are computed to understand the unique variance explained by each predictor. Deprivation sensitivity showed the highest unique variance explained in the model, followed by intrinsic motivation.

Table 2

Multiple regression table showing unstandardized coefficient (B), standard error, t statistic (t), significance value, and squared semi-partial correlations(sr^2). Hyperfocus in School (Dependent Variable) regressed through the need for cognition, Joyous exploration, Deprivation sensitivity, and Intrinsic motivation.

	B	Standard error	t	Sig.	sr²
(Constant)	1.122	0.285	3.937	<0.001	-
Need for cognition	0.058	0.080	0.721	0.472	0.001
Joyous exploration	-0.081	0.060	-1.348	0.179	0.004
Deprivation sensitivity	0.281	0.034	8.207	<0.001	0.140
Intrinsic motivation to know	0.172	0.052	3.286	0.001	0.023

The ANOVA test was also conducted on the dataset to understand whether the variance explained by the model is significantly different from 0. The mean of the variables is significantly different from 0 ($F(4,374) = 27.629, p = < 0.001$). Moreover, 22.2% is

explained by the model through the adjusted r squared ($R^2 = 0.230$, Adjusted $R^2 = 0.222$, $p < 0.001$).

Correlations (Pearson's correlations) between the variables were calculated to test the second research question. The strongest positive zero-order correlation was reported between joyous exploration and the need for cognition ($r = 0.629$, $p < 0.005$). The user's guide to the correlation coefficient was used to interpret the strength of the correlations (Akoglu, 2018). Hyperfocus was moderately correlated to deprivation sensitivity ($r = 0.452$, $p < 0.005$). Deprivation sensitivity and intrinsic motivation, which reported significant coefficients in multiple regression, showed a weak positive correlation ($r = 0.297$, $p < 0.005$). Interestingly, a moderate positive correlation is reported between joyous exploration and intrinsic motivation ($r = 0.520$, $p < 0.005$). All zero-order correlations between the variables were positive and significant, with an accepted significance level of 5% (0.05). The results show that intrinsic motivation and deprivation sensitivity significantly increased Hyperfocus in school, while all the cognitive motivators positively correlated with each other.

Discussion

The study aimed to understand whether the cognitive motivators (Need for cognition, Epistemic curiosity, and Intrinsic motivation) increase the frequency of the state of Hyperfocus in an academic scenario. There were five hypotheses addressed in this research paper. Firstly, it is hypothesized that individuals with high intrinsic motivation would have a higher frequency of hyperfocus experiences. Second, individuals with a high need for cognition would have a higher frequency of hyperfocus experiences. Thirdly, individuals with higher levels of joyous exploration will have a higher frequency of hyperfocus experiences. Fourthly, individuals with higher levels of deprivation sensitivity will have a higher frequency of hyperfocus experiences. Lastly, there would be a significant positive association between cognitive motivators.

The study's findings show that intrinsic motivation to know can significantly predict the frequency of Hyperfocus in an academic scenario. Therefore, the first hypothesis is accepted. Hektner & Csikszentmihalyi (1996) showed a moderate positive correlation between flow and academic intrinsic motivation in adolescents, similar to the current study. However, the study's correlation between Hyperfocus and intrinsic motivation was positive but weak. Hektner & Csikszentmihalyi used 281 adolescents as the sample from around the USA. The study was longitudinal, and similar questions were asked to the same participants in two years. Moreover, the research is old, and the materials must be updated.

The results obtained were in contrast to the findings of Li et al. (2004). Li et al. used 156 student samples in their study. They found that individuals with a high need for cognition have higher experiences of flow states, specifically higher levels of attention, perceived control, and curiosity. The findings can be different because the need for cognition may not be able to put an individual into a "deep" state of flow (Hyperfocus) but only a shallow flow state. The results also show that the need for cognition does not significantly predict the frequency of Hyperfocus. Therefore, the second hypothesis is not accepted.

Interestingly, joyous exploration did not significantly predict the frequency of Hyperfocus in an academic scenario. Therefore, the third hypothesis is not accepted. Although the second dimension of curiosity, deprivation sensitivity, significantly predicts the frequency of Hyperfocus. The fourth hypothesis is accepted. Schutte et al. (2020) showed that higher joyous exploration curiosity and knowledge-deprivation sensitivity were all associated with more flow. Fifty-seven students as the sample, with more females than males, were used in the study in Australia. The results are similar to the current study, with a similar sample. The study shows contradictory evidence for joyous exploration curiosity but consistent results for deprivation sensitivity. Again, flow is used in the study by Schutte et al. instead of Hyperfocus which can lead to different results. Moreover, reward-seeking is inherent to

joyous exploration, while deprivation sensitivity is information-seeking and the tension of not knowing some information (Kashdan et al., 2018). Hyperfocus experiences could be influenced by the tension of not knowing something rather than the reward-seeking nature. Additionally, the construct of epistemic curiosity needed to be measured, and research shows that individuals endorsing a greater deprivation sensitivity possessed high epistemic curiosity or "drive to know" (Kashdan et al., 2018).

In general, two significant predictors of Hyperfocus were found, but none of the predictors strongly influence Hyperfocus in school. One of the potential reasons for the weak influence of predictor variables is the higher number of female participants in the sample. Groen et al. (2020) showed small coefficients in their study, which explained that females have fewer occurrences of Hyperfocus. The frequency of Hyperfocus and influence of predictor variables was less due to the presence of more female participants.

Regarding the second research question, the results obtained in the current study were similar to the literature. All cognitive motivators were significant and positively correlated with each other. However, the highest correlational value found between the need for cognition and joyous exploration is a moderate positive association. There were no strong correlations found between the cognitive motivators in the study. The last hypothesis is accepted as significant positive correlations are found between the cognitive motivators.

Oudeyer et al. (2016) stated that curiosity is a form of intrinsic motivation that fosters active learning and spontaneous exploration. Moreover, in psychology, curiosity can be approached within the conceptual framework of intrinsic motivation. Only a little research shows the direct correlation between intrinsic motivation and curiosity because curiosity is believed to be a part of intrinsic motivation. Also, the need for cognition significantly correlates with curiosity (Olsen et al., 1984). Like the current study, Olsen et al. used 140 undergraduate students and showed a moderate correlation. Both studies use students as the

sample, which is the reason for similar answers. Olson et al. used the scale of curiosity which includes 16 specific curiosity subscales, different from the five-dimensional model of epistemic curiosity used in the current study.

Strengths, limitations, and future directions.

The study had several strengths and limitations that could affect the generalizability and validity of the results. Firstly, a large sample size (N=375) of students was gathered using convenience sampling. The students were recruited using advertisements. Gathering the sample using convenience sampling is more accessible as it saves time, effort, and money. However, the generalizability of the results could be better. The target population not only consists of students, which reduces the generalizability of the results. The sample comprises only students who study a BSc in Psychology at the University of Groningen. Also, most of the sample students were female, making the results highly generalizable to female students studying first-year BSC psychology. However, inferences about university students, in general, cannot be made due to the higher number of females. Additionally, advertisements were sent through the SONA link for first-year bachelor students. Each student needs to mandatorily collect a certain number of SONA credits in a year to pass; thus, many students enrolled as a participant with this incentive.

Moreover, some sample participants (n = 95) had also been diagnosed with psychological or brain disorders by a mental health care professional. The most common disorders were ADHD, depression, and anxiety. Therefore, the sample incorporates healthy individuals and individuals experiencing disorders better to understand the frequency of Hyperfocus among university students. This aids us in slightly increasing the generalizability of the results because there are many students suffering from mental health conditions in a general population of students. On the one hand, using a survey acted as an advantage because participants could complete the survey at their convenience. On the other hand, the

survey is online, which can increase the possibility of bias. The participants could have received information about the survey or the topic of the survey, which could have had an effect on the data. Each participant completed the survey at their convenience. Since the cognitive motivators vary amongst time and situations, which could have affected the answers for the survey; for example, if a student got his/her exam grades, it could manipulate with some variables such as motivation and curiosity. Moreover, the study was conducted during the winter, which could have led to low motivation in students in comparison to a study conducted in the summer.

Another area for improvement in the study is that the survey was time-consuming. The survey takes about twenty minutes to complete, which can reduce the participants' attention, and they could feel the urge to complete the survey faster. Moreover, an incentive (SONA credits or 1.5 euros) was rewarded to the participants upon completion of the survey. Although the incentive helped to gather a larger sample size, the incentive can also be a limitation of the study as participants could complete the survey to earn the reward. The incentive could harm the validity of the data because the participants could have participated for the incentive only. Participants who finished the survey in under 10 minutes were removed from the sample to control for individuals who completed the survey for incentive. Additionally, the results showed that the explained variance is relatively low, and the model needs to explain the predictor variables completely. The low explained variance means that the model is insufficiently explained. Since two predictor variables were insignificant, the model could have resulted in a low explained variance. Although the research has many strengths, the data should be interpreted cautiously due to the limitations present.

Future research should increase the explained variance by using more predictor variables to understand the variance better. Different types of intrinsic motivation and other traits can be included in the research to increase the explained variance. The study should also

include students from different courses, levels of previous education, and an even sample distribution regarding sex. This can help us obtain data that can be generalizable to all students and even understand the effect of Hyperfocus in an academic context. Surveys can be made less time-consuming so that the participants' attention is not diverted or distracted. This could reduce the fatigue bias of the current study. The study shows that some cognitive motivators- intrinsic motivation and deprivation sensitivity can increase the frequency of Hyperfocus in an academic scenario. Moreover, all the cognitive motivators are significantly positively correlated with each other.

Conclusion

This study shows that intrinsic motivation and deprivation sensitivity (a dimension of curiosity) could significantly predict an increase in the frequency of Hyperfocus. However, the need for cognition and joyous exploration (another dimension of curiosity) did not significantly predict the frequency of Hyperfocus in school. Positive significant correlations were found when a correlational analysis was conducted for the cognitive motivators. To conclude the second research question, intrinsic motivation, curiosity, and the need for cognition are all positively and significantly correlated. This research is a novelty in the topic of Hyperfocus and cognitive motivators. This study also helps to understand that Hyperfocus can be achieved by individual differences such as intrinsic motivation and epistemic curiosity.

References

ADDitude Editors. (2021, April 8). *The Good, the Bad, and the Ugly of Hyperfocus*.

ADDitude. <https://www.additudemag.com/hyperfocus-symptoms-positives-negatives-strategies/>

Ahlering, R. F., & Parker, L. D. (1989). Need for cognition as a moderator of the primacy effect. *Journal of Research in Personality*, 23(3), 313-317.

Akoglu, H. (2018). User's guide to correlation coefficients. *Turkish Journal of Emergency Medicine*, 18(3), 91–93. <https://doi.org/10.1016/j.tjem.2018.08.001>

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>

Banaschewski, T., Coghill, D., & Zuddas, A. (Eds.). (2018). Oxford Textbook of Attention Deficit Hyperactivity Disorder. *Oxford Medicine Online*. <https://doi.org/10.1093/med/9780198739258.001.0001>

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>

Cacioppo, J. T., & Petty, R. E. (1982). The need for cognition. *Journal of personality and social psychology*, 42(1), 116.

Cacioppo, J. T., Petty, R. E., Feinstein, J. A., & Jarvis, W. B. G. (1996). Dispositional differences in cognitive motivation: The life and times of individuals varying in need for cognition. *Psychological bulletin*, 119(2), 197.

- Conner, M. L. (1994, October 31). *ERIC - ED377013 - attention deficit disorder in Children and Adults: Strategies for Experiential Educators., 1994-Nov.* <https://eric.ed.gov/?id=ED377013>
- Csikszentmihalyi, M. (1990). *Flow: The Psychology of Optimal Experience* (1st ed.). Harper & Row.
- Deci, E. L., & Ryan, R. M. (1985). The general causality orientations scale: Self-determination in personality. *Journal of Research in Personality, 19*(2), 109–134. [https://doi.org/10.1016/0092-6566\(85\)90023-6](https://doi.org/10.1016/0092-6566(85)90023-6)
- Day, H. I. (1982). Curiosity and the interested explorer. *Performance & Instruction*
- Deci, E. L., & Ryan, R. M. (2012). Self-determination theory.
- Gray, B. E., Hahn, B., Robinson, B., Harvey, A., Leonard, C. J., Luck, S. J., & Gold, J. M. (2014). Relationships Between Divided Attention and Working Memory Impairment in People with Schizophrenia. *Schizophrenia Bulletin, 40*(6), 1462–1471. <https://doi.org/10.1093/schbul/sbu015>
- Groen, Y., Priegnitz, U., Fuermaier, A. B., Tucha, L., Tucha, O., Aschenbrenner, S., ... & Pimenta, M. G. (2020). Testing the relation between ADHD and hyperfocus experiences. *Research in Developmental Disabilities, 107*, 103789.
- Hahn, B., Harvey, A. N., Gold, J. M., Fischer, B. A., Keller, W. R., Ross, T. J., & Stein, E. A. (2016). Hyperdeactivation of the Default Mode Network in People with Schizophrenia When Focusing Attention on Space. *Schizophrenia Bulletin, 42*(5), 1158–1166. <https://doi.org/10.1093/schbul/sbw019>

- Hektner, J. M. (1996, March 31). *ERIC - ED395261 - A Longitudinal Exploration of Flow and Intrinsic Motivation in Adolescents., 1996-Apr.* <https://eric.ed.gov/?id=ED395261>
- Hektner, J. M., & Csikszentmihalyi, M. (1996). A Longitudinal Exploration of Flow and Intrinsic Motivation in Adolescents. *American Education Research Association*
- Hupfeld, K. E., Abagis, T. R., & Shah, P. (2019). Living “in the zone”: hyperfocus in adult ADHD. *ADHD Attention Deficit and Hyperactivity Disorders, 11*(2), 191-208.
- Isomura, T., Ogawa, S., Shibasaki, M., & Masataka, N. (2015). Delayed disengagement of attention from snakes in children with autism. *Frontiers in Psychology, 6*. <https://doi.org/10.3389/fpsyg.2015.00241>
- Jackson, S., & Csikszentmihalyi, M. (1999). *Flow in Sports: The keys to optimal experiences and performances* (First). Human Kinetics.
- Kashdan, T. B., Stikma, M. C., Disabato, D. J., McKnight, P. E., Bekier, J., Kaji, J., & Lazarus, R. (2018). The five-dimensional curiosity scale: Capturing the bandwidth of curiosity and identifying four unique subgroups of curious people. *Journal of Research in Personality, 73*, 130–149. <https://doi.org/10.1016/j.jrp.2017.11.011>
- Li, D., & Browne, G. J. (2016). The Role of Need for Cognition and Mood in Online Flow Experience. *Journal of Computer Information Systems, 46*(3), 11–17. <https://doi.org/10.1080/08874417.2006.11645894>
- Lins de Holanda Coelho, G., HP Hanel, P., & J. Wolf, L. (2020). The very efficient assessment of need for cognition: Developing a six-item version. *Assessment, 27*(8), 1870-1885.

- Litman, J. A. (2008). Interest and deprivation factors of epistemic curiosity. *Personality and Individual Differences, 44*(7), 1585–1595. <https://doi.org/10.1016/j.paid.2008.01.014>
- Loewenstein, G. (1994). The psychology of curiosity: A review and reinterpretation. *Psychological Bulletin, 116*(1), 75–98. <https://doi.org/10.1037/0033-2909.116.1.75>.
- Nguyen, S. M., & Oudeyer, P. Y. (2013). Socially guided intrinsic motivation for robot learning of motor skills. *Autonomous Robots, 36*(3), 273–294. <https://doi.org/10.1007/s10514-013-9339-y>
- Olson, K., Camp, C., & Fuller, D. (1984). Curiosity and Need for Cognition. *Psychological Reports, 54*(1), 71–74. <https://doi.org/10.2466/pr0.1984.54.1.71>
- Oudeyer, P. Y., Gottlieb, J., & Lopes, M. (2016). Intrinsic motivation, curiosity, and learning. *Motivation - Theory, Neurobiology and Applications, 257*–284. <https://doi.org/10.1016/bs.pbr.2016.05.005>
- Ozel-Kizil, E. T., Kokurcan, A., Aksoy, U. M., Kanat, B. B., Sakarya, D., Bastug, G., ... & Oncu, B. (2016). Hyperfocusing as a dimension of adult attention deficit hyperactivity disorder. *Research in Developmental Disabilities, 59*, 351-358.
- Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary educational psychology, 25*(1), 54-67.
- Schutte, N. S., & Malouff, J. M. (2020). Connections between curiosity, flow and creativity. *Personality and Individual Differences, 152*, 109555. <https://doi.org/10.1016/j.paid.2019.109555>
- Schüler, J. (2007). *[PDF] Arousal of Flow Experience in a Learning Setting and Its Effects on Exam Performance and Affect | Semantic*

Scholar. <https://www.semanticscholar.org/paper/Arousal-of-Flow-Experience-in-a-Learning-Setting-on-Sch%C3%BCler/44f3cfb6f36d5f7457b074fb0e68cb5135513d59>

Sklar, R. (2013). *Hyperfocus in Adult ADHD: An EEG Study of the Differences in Cortical Activity in Resting and Arousal States*. ProQuest Dissertations Publishing.

Strobel, A. (2014). Epistemic curiosity and Need for Cognition: Assessment and correlates. *Personality and Individual Differences*, 60, S8. <https://doi.org/10.1016/j.paid.2013.07.171>

Strobel, A., Fleischhauer, M., Enge, S., & Strobel, A. (2015). Explicit and implicit need for cognition and bottom-up/top-down attention allocation. *Journal of Research in Personality*, 55, 10-13.

Swan, A. (2021). *The Adult Hyperfocus and Motivation Scale: A Pilot Study* [Clinical dissertation]. Alliant international University.

Tang, X., Renninger, K. A., Hidi, S. E., Murayama, K., Lavonen, J., & Salmela-Aro, K. (2022). The differences and similarities between curiosity and interest: Meta-analysis and network analyses. *Learning and Instruction*, 80, 101628.

Thompson, E. P., Chaiken, S., & Hazlewood, J. D. (1993). Need for cognition and desire for control as moderators of extrinsic reward effects: A person \times situation approach to the study of intrinsic motivation. *Journal of Personality and Social Psychology*, 64(6), 987–999. <https://doi.org/10.1037/0022-3514.64.6.987>

Vallerand, R. J., Pelletier, L. G., Blais, M. R., Brière, N. M., Senécal, C. B., & Vallières, É. F.

(1993). Academic motivation scale (AMS-C 28), college (CEGEP)

version. *Educational and Psychological Measurement*, 52(53), 1992-1993.