The Possible Association Between Cognitive Motivators and the Frequency of Being In a Hyperfocus State

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Abstract

This research was conducted to investigate the relationships between academic intrinsic motivation, epistemic curiosity, need for cognition and the frequency of hyperfocus states while studying. The participants (N = 375) who participated in this research were first year psychology students from the university of Groningen. As a method, we used existing questionnaires that we adjusted and added together to one questionnaire. A multiple regression analysis was conducted over the predictor variables academic intrinsic motivation, epistemic curiosity and need for cognition and the outcome variable that was the frequency of hyperfocus states while studying. We also applied a Pearson's correlation analysis over the three cognitive motivators. Results show that one dimension of epistemic curiosity, called deprivation sensitivity, and academic intrinsic motivation are significantly associated with the frequency of hyperfocus while studying. The associations between need for cognition and the other dimension of epistemic curiosity, called joyous exploration, with the frequency of hyperfocus states while studying, was found nonsignificant. We also concluded that every individual predictor variable is positively associated with each other on at least a moderate strength level. The results of this study are of importance because there is a lack of research on the effect of motivation factors on hyperfocus in non-clinical cases and results can be important for optimizing study processes.

Keywords: Hyperfocus, Academic Intrinsic Motivation, Epistemic Curiosity, Need for Cognition

The Possible Association Between Cognitive Motivators and the Frequency of Being In a Hyperfocus State

Hyperfocus, a state of increased concentration where the noticing of other, non-task related, stimuli is strongly reduced, can help optimize task performances (Groen et al., 2021; Ashinoff & Abu-Ake, 2019). The tasks where a hyperfocus state can be reached, and so task performance can rise, can occur at various sorts of tasks, e.g. sport and academic tasks (Grotewiel et al., 2022; Cummings et al., 2022).

Over the years many different kinds of definitions have been given to the state of hyperfocus; Ashinoff & Abu-Ake (2019) defined hyperfocus as "a phenomenon that reflects one's complete absorption in a task, to a point where a person appears to completely ignore or 'tune out' everything else". Because the word 'absorption' can be vague, we will replace the word with another concept, which Groen et al. (2021) used in their research on hyperfocus, namely "enhanced attentional focus". Combining parts of both research definitions, the definition of hyperfocus in this article will be: "hyperfocus is a state of being where the attentional focus of a person is so enhanced, that other stimuli will be completely ignored/diminished".

A state of hyperfocus can be induced when a task is engaging or enjoyable (Ashinoff & Abu-Ake, 2019). The consequences of such a state are a strong maintained or selective attention, that other external stimulants are not perceived, and task performance improves (2019). Lots of research is conducted on the hyperfocus topic but most of these studies are aimed at the association between hyperfocus and the cognitive disorder ADHD. (Ayers-Glassey & MacIntyre, 2021; Grotewiel et al., 2022; Hupfeld et al., 2019, Holmes, 2006). All these studies concluded that hyperfocus states are more associated with participants diagnosed with ADHD compared to

undiagnosed participants. However, Groen et al. (2021), concluded that participants with ADHD did not differ with non diagnosed participants in the occurrence, frequency, duration and pervasiveness of hyperfocus states, except in social or educational settings. The researchers stated that this could be because these two settings require more controlled concentration and are less intrinsically rewarding for the participants with ADHD. They also showed a trend (although nonsignificant) that participants with ADHD were less likely to enter a state of hyperfocus, in comparison to undiagnosed participants, unless the tasks were intrinsically motivating, such as video games (Groen et al., 2021). More prior research on the influence of cognitive motivational aspects on the frequency of hyperfocus states in non-clinically diagnosed people is, to our knowledge, non-existing. Hence, this research will look deeper in that possible association in the hope that the association between some particular cognitive motivators and hyperfocus will be more clear at the end of this research. We think it is important to conduct such research because there is a possibility that hyperfocus can improve task performance when doing particicular activities (Ashinoff & Abu-Akel, 2019), such as studying, and the search for more effective ways to study is a never ending search.

First, because a state of hyperfocus can occur in various tasks (Grotewiel et al., 2022; Cummings et al., 2022) we have decided to narrow the scope on this aspect down to the frequency of hyperfocus states in academic activities and not other settings. Second, we chose to conduct research on three cognitive motivators because we predict, prior to the conducted research, that these three cognitive motivators contribute in facilitating hyperfocus states. The three cognitive motivators are: 1) academic intrinsic motivation, 2) need for cognition and 3) epistemic curiosity.

The first possible association which will be looked at is the one between academic intrinsic motivation and the frequency of hyperfocus states while studying. Academic intrinsic motivation is a state characteristic defined as getting inherently satisfaction out of studying and performing in activities in school itself. People who have a high level of academic intrinsic motivation are characterized with persistence, curiosity and they enjoy the process of studying on hard and new academic challenges (Gottfried, 2019). On the other hand, according to Ashinoff & Abu-Ake (2019), enjoyment in an activity is a requisite for being in a hyperfocus state. We predict an association between academic intrinsic motivation and the frequency hyperfocus states while studying because students with high levels of academic intrinsic motivation experience joy in studying. This joy in studying can have a facilitating effect on experiencing a hyperfocus state while studying (Ashinoff & Abu-Ake, 2019). This is why we predict that students with higher levels of the cognitive motivator academic intrinsic motivation will experience more states of hyperfocus while studying.

The second possible cognitive motivator which has a possible association with the frequency of hyperfocus states while studying is ‘need for cognition’. Need for cognition (NFC) is a trait characteristic in people which describes the tendency to engage in cognitive efforts. People with a high level of NFC engage in and relish thinking, especially when it involves solving complex effortful thinking problems (Grass et al., 2022; Cacioppo & Petty, 1984). We predict that there is an association because we assume that most students who are regularly engaged in academic activity come across activities which they perceive as difficult. These students will feel challenged and they need to put effort in this academic activity in order to do well. Second, these hard academic tasks will bring a tendency to engage in this academic task for people with high levels of NFC (Grass et al., 2022; Cacioppo & Petty, 1984). This tendency to

engage in this academic task can have a facilitating effect on entering a hyperfocus state (Ashinoff & Abu-Ake, 2019). This is why we predict that students with higher levels of the cognitive motivator NFC will experience more states of hyperfocus while studying.

The third possible association between a motivational aspect and the frequency of being in a hyperfocus state is the aspect of 'epistemic curiosity'. Epistemic curiosity can be defined as an individual's personality trait that describes the hunger for knowledge that motivates one to dissolve knowledge gaps, solve intellectual problems and learn about new concepts (Renninger et al., 2022; Mussel, 2010). Epistemic curiosity can be divided in two dimensions: (1) 'joyous exploration' and (2) 'deprivation sensitivity'. The difference between the two dimensions is that joyous exploration is a positive experience where people take a great pleasure in learning, their interest for learning leads to a higher level of well being (Kashdan et al., 2019). On the other hand, deprivation sensitivity is a more negative feeling where people feel anxious or stressed because they are aware that they miss information about a particular topic/subject. This feeling of discomfort will leave when the missing information gap is filled (Kashdan et al., 2019). We predict that there is an association between epistemic curiosity and the frequency of hyperfocus states while studying because epistemic curiosity has the same psychological mechanisms as another concept called situational interest, and can therefore be set identically to each other (Schmidt & Rotgans, 2020). This psychological mechanism is defined as the need for knowledge that appears when confronted with an epistemic knowledge gap. The confrontation with epistemic shortcomings is the idea behind learning in an academic context. A student needs to close gaps of knowledge on a particular topic in order to get a sufficient grade on that topic. Situational interest, and thus also epistemic curiosity, is evoked by focused attention and an emotional reaction that tends to be positive (Hidi, 1990; Hidi & Harackiewicz, 2000). We predict

that this focused attention in combination with a positive emotional reaction (joyous exploration), as a consequence of experiencing epistemic shortcomings (deprivation sensitivity) while studying, can facilitate a state of hyperfocus (Ashinoff & Abu-Ake, 2019). This is why we predict that students with higher levels of the cognitive motivator epistemic curiosity will experience more states of hyperfocus while studying.

The first research question will be about the possible association between academic intrinsic motivation, NFC and epistemic curiosity and the frequency of hyperfocus states while studying. Hypothesis 1 for this question is that there is a positive association between academic intrinsic motivation and experiencing a hyperfocus state while studying. Hypothesis 2 for this question is that there is a positive association between NFC and the frequency of hyperfocus states while studying. Hypothesis 3 for this question is that there is a positive association between epistemic curiosity and the frequency of hyperfocus states while studying.

The second research question is about the possible association between academic intrinsic motivation, NFC and epistemic curiosity. Hypothesis 4 of this research paper is that there is an association between academic intrinsic motivation and NFC. We predict this because people with high levels of academic intrinsic motivation enjoy the process of studying difficult academic tasks (Gottfried, 2019). NFC is characterized with the same enjoyment for doing complex, effortful thinking tasks. (Grass et al., 2022; Cacioppo & Petty, 1984). We predict that people with a trait characteristic of having a high level of NFC, will feel more frequent academically intrinsically motivated than people with low levels of NFC. Hypothesis 5 of this research paper is that there is an association between academic intrinsic motivation and epistemic curiosity. We predict this because academic intrinsic motivation is characterized by feelings of curiosity while doing academic tasks (Gottfried, 2019). The two dimensions of

epistemic curiosity, joyous exploration and deprivation sensitivity, are trait characteristics which involve the tendency to dissolve epistemic gaps and the level of enjoyment one gets from learning new information (Renninger et al., 2022; Mussel, 2010). Both activities occur while studying so we predict that people with high levels of epistemic curiosity will feel more often academically intrinsically motivated. Lastly, for hypothesis 6 we predict an association between NFC and epistemic curiosity. Where people with high levels of NFC enjoy complex effortful thinking tasks (Grass et al., 2022; Cacioppo & Petty, 1984), do people with high levels of epistemic curiosity like to dissolve knowledge gaps (Renninger et al., 2022; Mussel, 2010). For a thinking task to be complex and effortful, there needs to be a knowledge gap which has to be filled with new information. So we predict that the NFC trait can derive from the epistemic curiosity trait. Hence, we think an association will be found between these two concepts.

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 of a participant 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 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 while studying. 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 6-point Likert scale is used however it ranges '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., 2018) questionnaire measured the amount of enjoyment people get from engaging in cognitively challenging activities. This is an 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 NFC (“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., 2019) 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 thrill-seeking. 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 Cronbrach'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 the 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., 2018), the Utrecht Work Engagement Scale (Seppälä et al., 2009), the Five Dimensional Curiosity Scale (Kashdan et al., 2019), 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 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 hyperfocus states while studying. 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 states hyperfocus while studying. 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

To test the research questions, a multiple regression analysis and a correlation matrix has been run. To derive accurate inferences from the data, the five assumptions of multiple regression were first examined. First, the linearity assumption is assessed by partial regression plots and a plot of studentized residuals against the predictive values; this assumption was not violated. Second, homoscedasticity is investigated through a visual inspection of a 'studentized residuals vs. unstandardized predicted values' plot; this assumption was also not violated. Third, the independence of errors assumption is assessed using a Durbin Watson Test (Durbin & Watson, 1951) ; the outcome of this was 1.997, concluding that this assumption was not violated. Fourth, the normality assumption is assessed through visual inspection of a normality histogram; this assumption is also not violated. As last, the absence of multicollinearity assumption was

checked through a VIF score less than 10, this was the case so this assumption is also met. Altogether, no assumptions were violated so the procedure of interpreting the results from the multiple regression could be executed.

To begin with research question 1, results show that academic intrinsic motivation, epistemic curiosity and NFC together had a significant effect ($F(4,370)=27.629$, $p < .01$) on the frequency of hyperfocus states while studying. The R2adj. was 0.222, meaning that 22,2% of the variance in the frequency of hyperfocus states can be accounted for by the three predictor variables. Of all cognitive motivator scales, the mean score of the participants was the highest on the 'intrinsic motivation to know' scale ($M = 5.66$, $SD = 0.87$), and the lowest on the NFC scale ($M = 3.58$, $SD = 0.63$). The mean scores for each scale can be seen in table 1.

Table 1

Descriptive Statistics (Mean & Standard deviation) for Each Scales

Scale	*M*	*SD*
Hyperfocus in School	3.11	.84
Deprivation Sensitivity (epistemic curiosity)	4.35	1.24
Joyous exploration (epistemic curiosity)	5.12	.89
Intrinsic motivation to know	5.66	.87
Need for cognition	3.58	.63

Individually, academic intrinsic motivation ($b = 0.172$, $SE = 0.052$, *95% Cl* = 0.69 - 0.275, $t(374) = 3.286$, $p = 0.001$) had a significant positive effect on the frequency of hyperfocus states while studying. Based on these data, H_1 is supported. Second, NFC ($b = 0.058$, $SE =$

0.080, *95% Cl* = -.100 - 0.215, $t(374) = 0.721$, $p = 0.472$) did not have a significant effect on the frequency of hyperfocus states. Based on these data, H_2 is not supported. Third, one individual dimensions of epistemic curiosity had a positive significant effect on the frequency of hyperfocus states, that was deprivation sensitivity (b =0.281, $SE = 0.034$, *95% Cl* = 0.213-0.348, $t(374) = 8.207$, $p < 0.001$). The other dimension of epistemic curiosity, joyous exploration, had a nonsignificant effect on the frequency of hyperfocus states (b = -0.081, $SE = 0.060$, *95% Cl* = -0.199 - 0.037, $t(374) = -1.348$, $p = 0.179$,). Based on these data, H_3 is partly supported. Next to significant levels, we took a look at how much each individual predictor variable explained the total variance of the frequency hyperfocus states while studying. Deprivation sensitivity (sr^2 = 0.263) had the highest squared semipartial correlation with the frequency of hyperfocus states while studying. The predictor variable with the second highest squared semipartial correlation with the frequency of experiencing a hyperfocus state while studying was joyous exploration (sr^2 = 0.084). NFC (sr^2 = 0.001) and academic intrinsic motivation (sr^2 = 0.001) had the lowest squared semipartial correlation with the frequency of experiencing a hyperfocus state while studying.

The second research question was about if the motivational concepts, academic intrinsic motivation, epistemic curiosity and NFC, correlate with each other. We hypothesized that every individual predictor variable correlates significantly with all other predictor variables. For 2 variables to correlate significantly, we used the $P < 0.05$ rule proposed by Fisher (1925). To appoint levels of strength on a correlation between two variables we used the following values: ± 0.1 = weak relationship, ± 0.3 = moderate relationship and ± 0.5 = strong relationship (Cohen, 1988). To derive accurate inferences from the data, the three assumptions of Pearson's correlations were examined. The linearity-, no outliers- and normality-assumptions were already

met in the multiple regression assumption analysis, so no assumptions of the Pearson's correlation were violated. The procedure of interpreting the results from the multiple regression could be executed. The correlation matrix can be seen in table 2.

Table 2

Pearson correlation coefficients for the Four Cognitive Motivators

Variables	Joyous Exploration	Deprivation Sensitivity	Academic Intrinsic Motivation	Need For Cognition
Joyous Exploration				
Deprivation Sensitivity	0.37			
Academic Intrinsic Motivation	0.52	0.30		
Need For Cognition	0.63	0.38	0.42	

Note: All correlations are significant ($p < 0.001$)

First, Academic intrinsic motivation correlated significantly positive on a moderate level with NFC ($r = 0.422$, $p < 0.001$). Thus, H_4 is supported by our data. Second, academic intrinsic motivation correlated significantly positive on a strong level with joyous exploration ($r = 0.520$, $p < 0.001$), and significantly positive on a moderate level with deprivation sensitivity ($r = 0.297$, $p < 0.001$). Thus, H_5 is also supported by our data. Lastly, NFC correlated significantly positive on a strong level with joyous exploration ($r = 0.629$, $p < 0.001$), and significantly positive on a moderate level with deprivation sensitivity ($r = 0.383$, $p < 0.001$). Thus, H_6 is also supported by

our data. Overall, every individual predictor variable correlates significantly with all other predictor variables.

Discussion

This study was conducted to determine if (1) various forms of cognitive motivators, in the form of epistemic curiosity, academic intrinsic motivation and need for cognition, can influence the frequency of hyperfocus state while studying, and (2) if these cognitive motivators correlate with each other.

To test research question 1, several hypotheses were stating that the three cognitive motivations can influence the frequency of experiencing a hyperfocus state while studying. We hypothesized that higher scores on the three cognitive motivators, associated with more experiences in a hyperfocus state while studying. Looking at the results, it can be concluded that academic intrinsic motivation and deprivation sensitivity both have an association with the frequency of hyperfocus states while studying. This means that students with high levels of academic intrinsic motivation and deprivation sensitivity experience a state of hyperfocus while studying more frequently than students with low levels of these two cognitive motivators. These associations were not found for joyous exploration and NFC. Thus, after the conducted research the conclusion can be made that hypothesis 1 is supported by the data, hypothesis 2 is not supported by the data and hypothesis 3 is partly supported by the data.

First, we hypothesized that higher levels of academic intrinsic motivation will associate with more frequent experiences of a hyperfocus state while studying. Gottfried (2019) stated that individuals with high levels of academic intrinsic motivation are getting inherently enjoyment out of studying and in performance of school activities. Ashinoff & Abu-Ake (2019) stated that enjoyment while doing an activity is a requisite for entering a hyperfocus state. We predicted that

students with high levels of academic intrinsic motivation feel more joy while studying than students with low levels of academic intrinsic motivation. This more feeling of joy while studying would led, according to our prediction, to more experiences of hyperfocus state while studying. According to this research, higher levels of academic intrinsic motivation is indeed associated with more frequent states of hyperfocus in students while studying. This direct association between academic intrinsic motivation and the frequency of experiencing a state of hyperfocus in academic context is, to our knowledge, a new finding. However, researcher Savelieva and Volk (2017) showed in their research that elements of a 'flow state' also associate with 'intrinsic motivation to learn' in an academic context. Flow states are not precisely the same as hyperfocus states but they have many similarities (Ashinoff and Abu-Ake, 2019). So previous research did implicitly suggest this finding, but this is the first research that directly showed the association between academic intrinsic motivation and hyperfocus in an academic context.

Next, we looked at the possible relationship between epistemic curiosity and the frequency of hyperfocus states while studying. The hypothesis for epistemic curiosity in total, so both joyous exploration and deprivation sensitivity, was that higher levels of epistemic curiosity will associate with more frequent experiences of a hyperfocus state while studying. After looking at the data, the conclusion can be made that deprivation sensitivity has a positive effect on the frequency of how often a student will experience a state of hyperfocus while studying, but that effect is not found for joyous exploration. Our theoretical reasoning that the enhanced focus, experienced because of the noticing of a gap of knowledge (deprivation sensitivity), could facilitate a state of hyperfocus while studying (Kashdan et al., 2019) is thus supported by the results of our research. On the other hand, the results of our research do not support our prediction that the focused attention in combination with a positive emotional reaction (joyous

exploration dimension) could facilitate states of hyperfocus (Hidi, 1990; Hidi & Harackiewicz 2000). Thus, the two individual dimensions of Epistemic Curiosity are both different associated with the frequency of experiencing a hyperfocus state while studying.

The last cognitive motivator that has been researched is the need for cognition. The hypothesis for this particular motivational factor was that higher levels of NFC will lead to more frequent experiences of a hyperfocus state while studying. We predicted this because people with high levels of NFC feel more engaged in tasks which require cognitive effort (e.g. academic tasks) than people with low levels of NFC (Grass et al., 2022; Cacioppo & Petty, 1984). Like said earlier, the feeling of engagement while doing a task is a requisite for entering a state of hyperfocus (Ashinoff & Abu-Ake, 2019). Because of this we predicted that higher levels of engagement will lead to more experiences of hyperfocus states while doing a task. Looking at the data, we could not find an association between NFC and the frequency of hyperfocus states while studying. Reasons for this could be that the academic tasks do not cognitively challenge the students with high levels of NFC enough that they feel more engaged with the academic tasks. Another reason that the association between NFC and the frequency of hyperfocus was not found could be that the academic tasks are too challenging for the students with high levels of NFC. Smith (2007) found out that NFC influenced flow through moderation of perceived skill. If a participant perceived their level of skill as too low, it could have an impede influence on experiencing flow states. All students in our research go to the highest level of education available for them (university), so perceiving academic tasks as too challenging, even for students with high levels of NFC, could be a realistic possibility. We want to highlight that a flow state has many similarities with a state of hyperfocus but that it is not the exact same concept as hyperfocus. A proposal for future research is to investigate if the association between NFC and

frequencies of hyperfocus is not found because the academic tasks were cognitively too challenging or too easy for the students.

Both academic intrinsic motivation and a dimension of epistemic curiosity, that is sensation deprivation, have positive associations with the frequency of students experiencing a state of hyperfocus while studying. On the other hand, NFC and the other dimension of epistemic curiosity, that is called joyous exploration, do not have a found association with the frequency of how hyperfocus states while studying. A theoretical reason for this distinction could be that both NFC and joyous exploration rely on a motivation that includes a feeling of joy while studying, whereas sensation deprivation relies more on a stressful motivation to fill a gap of knowledge. More research on discovering why a 'stressful motivation' has a significant association with the frequency of hyperfocus states and the 'joyous motivations' do not have a significant association is needed. A prediction could be that the hyperfocus states could be influenced by the stress levels in our body. It is known that high levels of cortisol could have a negative effect on flow experiences (Peifer et al., 2014). We saw a linear relation between deprivation sensitivity and hyperfocus so we predict that the level of cortisol is linearly related to the frequency of hyperfocus states while studying. Future research could look into this relationship.

The second research question was about if the three motivational factors, academic intrinsic motivation, epistemic curiosity and NFC, were positively associated with each other. Firstly, for hypothesis 4, we predicted that academic intrinsic motivation and NFC are associated with each other in a way that high levels of (trait) NFC could facilitate higher levels of (situational) academic intrinsic motivation in the experience of hard academic circumstances (Gottfried, 2019; Grass et al., 2022; Cacioppo & Petty, 1984). There is indeed a moderately strong, positive, association between academic intrinsic motivation and NFC. This is in line with

previous research (Gottfried et al., 2017) where the researchers proposed an association between NFC and academic intrinsic motivation. In their 28 eight years long longitudinal study, they stated that high levels of academic intrinsic motivation in young students is associated with high levels of NFC in adulthood. Next, for hypothesis 5, we predicted that people with high levels of the (trait) characteristic epistemic curiosity will feel more often academically intrinsically motivated while doing study tasks than people with lower levels of epistemic curiosity. We predicted this because epistemic curiosity is a motivation that one has to dissolve knowledge gaps, solve intellectual problems and learn about new concepts (Renninger et al., 2022; Mussel, 2010). All these features are seen in studying in an academic context, so we predicted that people with high levels of epistemic curiosity will feel more often intrinsically academically motivated. Looking at the data, there is indeed a positive association between academic intrinsic motivation and epistemic curiosity. The positive association between academic intrinsic motivation and joyous exploration is strong while the positive association between academic intrinsic motivation and deprivation sensitivity is moderate. This is in line with previous research from Litman et al. (2010) where they also proposed an association between academic intrinsic motivation and epistemic curiosity in non-students. Our research is, to our knowledge, the only study which stated a conclusion about the direct association between academic intrinsic motivation and epistemic curiosity in students. Lastly, for hypothesis 6, we predicted a positive association between NFC and epistemic curiosity. We predicted this because people with high levels of NFC enjoy complex effortful thinking tasks (Grass et al., 2022; Cacioppo & Petty, 1984), and people with high levels of epistemic curiosity like to dissolve knowledge gaps (Renninger et al., 2022; Mussel, 2010). For a thinking task to be complex and effortful, there needs to be a knowledge gap which has to be filled with new information. Our prediction turned out to be correct. The

positive association between NFC and joyous exploration is strong while the positive association between NFC and deprivation sensitivity is moderately strong. This is in line with previous research conducted by Nettelbeck and Powell (2014). This study, originally conducted to look into the possible association between intellectual curiosity and academic success, also showed a (strong) association between epistemic curiosity and NFC.

Note that joyous exploration has a less strong association with deprivation sensitivity than with the other two cognitive motivators, and that while the two are different dimensions for the same construct (epistemic curiosity). We recommend follow-up studies to search for reasons on how this remarkable difference in association strongness is possible. We predict that this difference is because deprivation sensitivity is, as only predictor variable, not related to a positive feeling. With the other three cognitive motivators, a feeling of joy is involved. We propose that this is the reason why joyous exploration is more associated with NFC and academic intrinsic motivation than with deprivation sensitivity.

The results of this research are important for multiple reasons. We tried to paint a more specific picture of the influence of cognitive motivators on the frequency of hyperfocus states in students. This is, to our knowledge, never done. We concluded that cognitive motivators can indeed influence states of hyperfocus. These conclusions are important because students could benefit from more frequent or more intense states of hyperfocus to optimize their study performances (Ashinoff & Abu-Ake, 2019; Groen et al. 2021). However, we only tested for associations between the cognitive motivators and the frequency of experiencing a state of hyperfocus in academic context, we did not give direction to that association. Hence, a causal association could be investigated in future studies. Another reason why our findings are important is because we now know that three cognitive motivators are positively and

significantly associated with each other. This is a strong foundation for more research on the three factors and their relations and possible causal relationships. For example the causal relationship between predictor variables NFC or epistemic curiosity and as outcome variable academic intrinsic motivation. We predict that levels of academic intrinsic motivation could be a consequence of cognitive motivation, for example NFC and epistemic curiosity.

This research has a number of limitations. The first limitation of this study is that it only focused on first year psychology students. Because of this specific sample, this study has not a high degree of external validity. Follow-up studies should conduct research on a more diverse set of students. A longitudinal study which consists of students who complete our questionnaire every 6 months could be a useful way to make inferences about the possible fluctuations on the effect that the three motivational factors have on the frequency of hyperfocus states. This is interesting to know because intrinsic academic motivation is a state motivation and can drop and rise through the years of studying. We would like to know how strong the frequency hyperfocus states fluctuates along with the level of being academically motivated. Our study could be the stepping stone to a wide range of research on the effect of motivation and the frequency-/intensity of hyperfocus states. Another methodological limitation of this study is that the majority of participants was female (76% in comparison with 23,5% male). Because the data set is strongly influenced by female appearances, and because this study didn't control for sex, overall results are skewed to a more female variation of the researched effects. This can be influential because Tanaka et al. (1988) found a significant difference in one subscale of NFC (cognitive persistency). Women scored higher than men on this subscale of NFC. The sex difference in (a dimension of) NFC could cause different outcomes in the association between the cognitive motivators and the frequency of hyperfocus states between men and women. We

recommend that follow-up studies look deeper into the influence of sex on the effect that the three cognitive motivators have on the frequency of hyperfocus states.

This research is conducted with the purpose to investigate the relationship between academic intrinsic motivation, epistemic curiosity, NFC and the frequency of hyperfocus states while studying. Results show that academic intrinsic motivation and deprivation sensitivity are significantly associated with the frequency of hyperfocus states in students. The association between joyous exploration and NFC and the frequency of hyperfocus states in academic context is not found. These findings are relevant because we now have a better understanding of the influence of the three cognitive motivators on the frequency of hyperfocus states while studying. This could in the future potentially help with optimizing student motivation in order to experience more states of hyperfocus with all its positive consequences. Next to that we tried to answer the question if the three cognitive motivators are associated with each other. We concluded that every individual predictor variable is positively associated on a (at least) moderate strength level. This is a strong foundation for other research regarding these three cognitive motivators and a potential opening for a more causal structured research.

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