Using Cognitive Motivation Aspects to Predict Flow in Studies in Psychology Students

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Abstract

Earlier research suggested associations between flow and the cognitive motivational aspects curiosity, need for cognition and academic intrinsic motivation. This paper looks at two questions: what kind of predictive value do these three concepts have on flow and if these three concepts are associated with each other. This study tries to fill in a gap of knowledge about the predictability these cognitive motivational aspects have together on flow in studies, and replicates some findings of the associations between the aspects themselves. An online questionnaire was employed to research this, that measured the level of curiosity, need for cognition, academic intrinsic motivation and flow in studies in 370 first year psychology students at the University of Groningen. The multiple regression showed only certain (sub)scales to be significant positive predictors of flow, which were: one subscale of curiosity: stress tolerance, two subscales of intrinsic motivation: intrinsic motivation toward accomplishment and intrinsic motivation toward knowledge, and need for cognition. The associations between curiosity, need for cognition and intrinsic motivation were almost all significant and positive, ranging from weak to strong correlations. Only stress tolerance and both intrinsic motivation toward accomplishment and intrinsic motivation toward knowledge were not significantly related to each other. The hypotheses are supported by the results. These results could help to understand flow in studies and make models to predict flow in studies more accurately, which could help with students' learning engagement and procrastination.

Keywords: flow, academic intrinsic motivation, curiosity, need for cognition, psychology students

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Probably everyone has experienced Flow. Flow is that certain cognitive state where you lose track of time while you are focused on a certain activity, for example while cleaning or writing. This paper focuses on flow during studying, specifically how certain cognitive motivation aspects - which are stable, mental characteristics that influence individuals' behavior - are related to the flow state.

The Concept of Flow

Csikszentmihalyi (1975) was the first to define flow. This study uses Barthelmäs and Keller's (2021) definition of flow, as it provides a systematic review of flow and takes many previous flow research into account. Flow is a subjective experience during execution of a skill-related activity (Barthelmäs & Keller, 2021). The combination of distinct experiential states is characteristic of flow, specifically: reduced reflective self-consciousness, modified experience of time, involvement and enjoyment of the activity, focused concentration, strong feeling of control and that the activity feels rewarding. But, solely the experience of any of these states does not mean one is in a state of flow. Antecedents that are needed to come into the flow state are: clear goals, immediate and unambiguous feedback and a balance of perceived skills and perceived task demands (Barthelemäs & Keller, 2021).

Mehta and Vyas (2022) look at flow in the everyday student life. Flow is important in education, as flow is regarded as the driver of learning. Flow has a strong positive correlation with learning engagement in students (Brom et al., 2017). To help students discover flow, one can change the activity settings and structure so that they encourage flow or restrict it less (Mehta & Vyas, 2022). In school, a teacher could try to make flow possible by (for example) teach the students to give themselves feedback, focusing on the progress instead of results and matching the challenges and skills of the students by letting them seek their own level of challenge (Csikszentmihalyi, 2014). Incorporating the prerequisites needed to enter the flow

state into the educational system, could help students to reduce procrastination (Lee, 2005) and find the motivation to go on learning the rest of their life (Csikszentmihalyi, 2014). The current study looks at flow as a unidimensional construct to clearly see what influences flow as a whole, without complicating the research methods used.

Cognitive Motivation Aspects and Flow

The cognitive motivation aspects in this study are: curiosity, academic intrinsic motivation and need for cognition. These aspects are part of the motivational drives of a person, so it could influence the flow experience.

Curiosity

Curiosity is a desire for new knowledge, information or incentive to resolve gaps of knowledge (Arnone & Grabowsky 1992; Berlyne 1954; Litman 2005). This description includes the multiple dimensions that curiosity embodies (Grossnickle, 2016). There are five dimensions in curiosity (Kashdan et al., 2018). Joyous exploration entails the openness to experiences, initiates personal growth and derives positive emotions from new experiences. Deprivation sensitivity is being intellectually engaged, complex and abstract thinking, solving problems and seeking information. High stress tolerance individuals do not experience as much confusion, doubt and distress when exploring new things. Social curiosity is wondering what others are thinking and doing. It might not be relevant to flow, as social curiosity is most relevant with prosocial functioning. The dimension thrill seeking is experiencing intense and complex experiences and to risk social, financial and physical safety to have these experiences. It is unlikely that this relates to flow in studies, as there are no intense experiences during studying.

Schutte and Malouff (2020) found when focused on an activity, greater levels of curiosity were related to greater flow. The participants of this study, Australian university students, had to write a program about water conservation as the focus activity, which is

comparable to studying. This study focused on joyous exploration, deprivation sensitivity and stress tolerance, which were all found to be significantly positively associated with flow. Nakamura and Csikszentmihalyi (2002) state that curiosity motivates the intrinsic qualities of certain activities, as it is part of the autotelic personality, and that this motivation can help to come into the flow state more easily. This autotelic personality is defined by several traits that enable a person to enter and stay in a flow state (Csikszentmihalyi, 1997), of which curiosity is one, together with traits such as persistence and low self-centeredness that also help a person to be more intrinsically motivated. An autotelic individual spends more time in flow than others, the personality is even measured by how much time they spend in flow (Adlai-Gail, 1994; Hektner, 1996).

Intrinsic Motivation

The intrinsic motivation in this study is the specific intrinsic motivation to engage in academic activities. This differentiates intrinsic motivation from curiosity or need for cognition as it is not a trait and thus, we cannot assume they have the same explanatory value as traits do.

Heckhausen (1964) viewed intrinsic motivation when an activity is in and of itself the motivational force, with the condition that the end product of the end goal is the same as the activities goal (Heckhausen, 1991). This motivation causes you to perform an activity without expecting enjoyment or an external reward (Ryan & Deci, 2000). Academic intrinsic motivation has multiple dimensions (Vallerand, 1992). Intrinsic motivation toward knowledge is the need for knowledge and doing something for the satisfaction of learning. Intrinsic motivation toward accomplishment is about engaging in activities to feel competent and to accomplish things. The focus is more on the process when one tries to accomplish anything than actually achieving something. Intrinsic motivation to experience stimulation is taking part in an activity to experience stimulating sensations caused by the engagement in this activity.

Intrinsic motivation is often associated with flow (Fong et al., 2015; Kowal & Fortier,

1999). Csikszentmihalyi (1975) described flow as an intrinsically motivated and positive state of being, it can by definition be seen as an intrinsically motivated state (Csikszentmihalyi, 1990; Csikszentmihalyi & Csikszentmihalyi, 1988; Haworth & Evans, 1995; Kowal & Fortier, 1999). Ljubin-Golub, Rijavec and Olčar (2020) studied the role of flow and motivation in student burnouts using Croatian university students, which found a positive relation between intrinsic motivation and academic flow. Rijavec et al. (2016) studied how often students experience flow with a female university student sample and found that flow in academic activities enhances when students have active involvement in learning. Intrinsic motivation toward knowledge and intrinsic motivation toward accomplishment both facilitate active involvement in learning, thus can increase the chance of flow.

Need for Cognition

Need for cognition is a dispositional likelihood to enjoy and engage in thinking or demanding cognitive activity (Cacioppo & Petty, 1982). People with high need for cognition are generally more positive toward situations requiring logical thinking and problem solving than people with lower need for cognition (Cacioppo, Petty, Feinstein, & Jarvis, 1996).

Juric (2017) studied the role of need for cognition in the reading behavior of students, using a survey on a sample of undergraduate university students. Need for cognition had significant correlations with the behavior of losing track of time and reading the whole book at once, which are typical of the flow experience.

Curiosity, Intrinsic Motivation and Need for Cognition

The three cognitive motivation aspects in this paper seem interrelated. Curiosity is a motivating trait, as is the intrinsic motivation characteristic (Litman, 2005; Loewenstein, 1994). Litman (2005) found this while proposing a new theoretical model for curiosity, which is based on two systems hypothesized to underlie motivation (Berridge, 1999; Berridge & Robinson, 1998). Loewenstein (1994) reviewed and reinterpreted multiple papers about curiosity,

concluding that multiple studies defined curiosity as an intrinsically motivated trait. For example, White (1959) states that curiosity stems from an internal motivation to master someone's surroundings and Kagan (1972) described curiosity as the motivation to resolve uncertainty or the motive to know, which resembles intrinsic motivation to know. Curiosity can help activate intrinsic motivation, namely the intrinsic motivation toward knowledge (Nakamura and Csikszentmihalyi, 2002), which was concluded through information from multiple papers and anecdotal stories.

Secondly, there is a relation between need for cognition and curiosity. Olson, Camp and Fuller (1984) found a strong positive correlation between these two traits. They surveyed a sample of undergraduate students to measure curiosity with eight different scales and need for cognition with one scale. Need for cognition significantly positively correlated with seven curiosity scales. The sensation seeking subscale, which resembles joyous exploration, was moderately positive associated with need for cognition. The subscales complexity and thinking resemble deprivation sensitivity, which were both moderately positively correlated to need for cognition. Both trait anxiety and state anxiety, which could resemble the opposite of stress tolerance, were negatively associated with need for cognition.

Thirdly, Amabile et al. (1994) found a significant positive correlation between intrinsic motivation and need for cognition. This study tested the Work Preference Inventory which measures intrinsic and extrinsic motivation in students and working adults. The intrinsic motivation scale had two subscales that both correlated positively with need for cognition: challenge and enjoyment. The subscale challenge has items such as "I enjoy trying to solve complex problems", which resembles intrinsic motivation toward knowledge. The subscale enjoyment has items such as "What matters to me most is enjoying what I do", which resembles intrinsic motivation to experience stimulation.

Hypotheses

Our primary research question asks how the cognitive motivational aspects relate to flow in studies. We hypothesize that: Curiosity - with the subscales deprivation sensitivity, joyous exploration and stress tolerance - positively predicts flow in studies. Intrinsic motivation - with the subscales intrinsic motivation toward knowledge, intrinsic motivation toward accomplishment and intrinsic motivation to experience stimulation - positively predicts flow in studies. Need for cognition positively predicts flow in studies.

Our secondary research question asks how the cognitive motivational aspects relate to each other. We hypothesize that: Curiosity is positively correlated with intrinsic motivation, need for cognition is positively correlated with intrinsic motivation and need for cognition is positively correlated with curiosity.

Methods

Participants

The population of interest in this study are first-, second- and third- year psychology students at the University of Groningen. Thus, our sample was gathered from the mentioned population. The second- and third year student participants of this study were recruited via flyers placed around the faculty of Behavioral and Social Sciences buildings or a WhatsApp link shared in psychology group chats. First year students could only join via SONA, a research platform the University of Groningen uses where first year psychology students earn credits by participating in research studies. The first-year psychology students were rewarded with SONA points, the second- and third-year students were rewarded with a financial compensation of 1.5 Euro. We will not include the data of the second- and third-year student participants of this study in the data analysis, in order not to introduce a systematic source of variability due to the insufficient data collected.

There were in total 394 participants in the initial dataset. Seventeen of them had incomplete responses or failed either of the two attention checks, which makes their

responses unreliable. Their data thus have not been included in the analysis. Seven additional participants were excluded based on detecting the corresponding values as multivariate outliers with Mahalanobis distance. The final sample consisted of 370 participants between the ages 17 and 35 (M = 19.765, SD = 2.106). Men composed 23.8% of the participants, 75.7% were female and 0.5% preferred not to say which gender they identify with. From the different nationalities that participated, 50% were Dutch, 22.2% were German, and 27,8% had other nationalities.

Materials

To gather demographic information, respondents were then asked to indicate their biological sex (required to choose from options Male, Female and Prefer not to say), age in years, and nationality (Dutch, German or Other, in which case they could specify). Moreover, participants provided their professional status (Student, Working Student or Other) and chose from seven options to indicate level of education.

To measure flow experiences, the study utilizes the short version of the Dispositional Flow Scale (DFS-2; Jackson, Martin & Eklund, 2008). The DSF-2 includes nine items on which participants indicate the frequency of experienced flow states. Modifications to the instructions were implemented in order to align the scale to the aim of the current study. Instructions were changed from asking about specific experiences of flow from a recently executed activity to general flow experiences in studies. Participants were requested to rate "thoughts and feelings [they] may experience during [their] studies" on the basis of frequency of these experiences. The scale included questions such as "When I am studying… I am competent enough to meet the demands of the situation", which participants then ranked on a five-point Likert scale ranging from 1 (never) to 5 (always / everyday). As to obtain a single value for the unidimensional flow construct, the mean average of the participants' scores on the nine items was calculated and used as the dependent variable. To check for reliability of the new calculated variable of flow, Cronbach's Alpha was determined at α =.737. This value

indicates the reliability of the variable as sufficient, allowing for the creation of a single variable and to test for potential relations to the independent variables.

The Five-Dimensional Curiosity Scale was applied to investigate the degree to which participants described themselves as curious (5DC; Kashdan et al., 2018). The questionnaire consists of 25 items, each of them with an answer option of a seven-point Likert scale. An example of items is the statement "I find it hard to explore new places when I lack confidence in my abilities" which participants had to rank from 1 (does not describe me at all), to 7 (completely describes me). The questions are categorized into five distinct subscales - joyous exploration, deprivation sensitivity, stress tolerance, Social Curiosity and Thrill Seeking - each of them consisting of 5 items. All questions falling under the stress tolerance dimension were reversed-scored. In the present research, curiosity was treated as a multidimensional variable based on three dimensions; joyous exploration, deprivation sensitivity and stress tolerance. In accordance with the lack of theoretical relevance, the Social Curiosity and Thrill Seeking subscales have been excluded from our analysis. Participants' scores on the four items of joyous exploration were combined to a mean average justified by the high internal reliability (α = .769). We proceeded similarly in case of the subscales stress tolerance (α = .810) and deprivation sensitivity (α = .832).

We investigated the need for cognition by utilizing the Need For Cognition Scale (NCS-6; Coelho, Hanel & Wolf, 2020) which includes six items on individual characteristics. The participants were asked to indicate to what extent a statement is congruent with a personal characteristic on a five-point Likert scale ranging from 1 (extremely uncharacteristic of me), to 5 (extremely characteristic of me). One example of a statement of a characteristic is "I would prefer complex to simple problems", to which participants answered to what extent this describes them, or what they believe about themselves. Two out of the six questions are negatively phrased ("Thinking is not my idea of fun"), so these items were reverse-coded for

the initial statistical analyses. The mean average of six items was combined and need for cognition was treated as a unidimensional construct. The internal consistency of these six items to measure need for cognition's was calculated at $\alpha = 0.726$.

In order to explore participants' motivation in educational settings, the Academic Motivation Scale (AMS; Vallerand et al., 1992) was administered consisting of 28 statements. The scale consists of seven subscales that assess the dimensions of motivation toward education, namely: intrinsic motivation toward knowledge, intrinsic motivation toward accomplishment, intrinsic motivation to experience stimulation, extrinsic motivation - identified, extrinsic motivation - introjected, extrinsic motivation - external regulation as well as amotivation. All subscales consist of four items and assess the participants motivation about attending university and pursuing a degree. In the questionnaire, respondents were required to indicate how much they could identify with the stated reasons to go to university or college on a seven-point Likert scale ranging from 1 (does not correspond at all) to 7 (corresponds exactly). One example of a statement is "Because I want to show myself that I can succeed in my studies.", which assesses motivation, but also "I don't know what I am doing at University", which assesses amotivation. We treated academic motivation as a multidimensional variable based on the seven subscales, however we excluded the three subscales related to extrinsic motivation due to lack of relevance and Amotivation based on its adverse effects on the homoscedasticity assumption. As to obtain a single value for each of the remaining three dimensions, the mean averages of the participants' scores on each subscale were calculated. To check for internal reliability, Cronbach's Alphas were computed for the three new variables; intrinsic motivation toward knowledge($\alpha = .825$) intrinsic motivation toward accomplishment ($\alpha = .779$) and intrinsic motivation to experience stimulation *(*$\alpha = .820$).

In the scales included in the current research, two attention checks were implemented to see if participants' responses were reliable. The first attention check was included after the

13th item of the Five-Dimensional Curiosity Scale, the second one came after the 19th item of the Academic Motivation scale. In both cases, participants were asked to choose a specific answer from the Likert scale (e.g., "barely describes me") to confirm that they have been paying attention.

Procedure

The online survey was developed using Qualtrics. Ethical approval by the research committee was obtained prior to distribution. After providing information regarding their study year, the participants are informed about the premise and goals of the study. Following this, the participants are asked to give their informed consent to continue the study. Demographic background, including sex, age, nationality, and current occupation is then established. The participants are then asked to provide their educational background. The blocks following this consist of scales to assess the constructs of interest, namely Curiosity, Need for Cognition, Academic Motivation, Work Engagement, Hyperfocus, Dispositional Flow, and ADHD. Each construct is being measured on a single Scale. In order to prevent order biases, two randomization processes took place throughout the survey. The scales of Curiosity, Need for Cognition, and Academic Motivation were randomized together, while Work Engagement, Hyperfocus and Dispositional Flow were the second randomization. The independent and dependent variables' blocks followed a predetermined order, thus, it was in fact a pseudo-randomization. The following block puts forth questions assessing the mental health of the participants on a general level and asks whether the person was diagnosed with a mental disorder within the last six months. The block after assesses the potential intake of prescription drugs and potential misuse of it in the past 6 months. The questionnaire is completed after approximately twenty minutes after which the participants are debriefed and finish the survey by providing indications towards the quality of their answers. After finishing the survey, the

participants received their rewards.

Design

The study is designed as quantitative research using correlational design, each participant taking part one time in the research. In this study, we are examining the predictive relationship between cognitive motivational aspects and experienced flow frequency in the student population of the Psychology programme, and therefore run a multiple regression analysis. The independent variables (IVs) are three motivational aspects: the Need for Cognition, Curiosity, and Academic Motivation. The dependent variable (DV) is the experienced frequency of flow in academic studies. Further, we examine the interrelation between cognitive motivation aspects by calculating Pearson's r for each combination of the predictors.

Results

Assumptions

Cook's Distance and Mahalanobis Distance were used to check for outliers. Cook's checked for deviants of normality, there was no need to remove data. Mahalanobis checked for multivariate outliers, which removed 7 outliers. The variables are normally distributed, this was checked by examining the histogram of the residuals data (Appendix, Chart 1). The residual plot was used to check for heteroscedasticity and linearity between variables (Appendix, Chart 2). There was no pattern, thus the assumptions are met. All the Pearson's bivariate correlations are below .80 (Table 2), thus the assumption of multicollinearity is met.

Descriptives

All the variables had above average scores (Table 1). The average of the five-point Likert scale is 2.500 on which flow and need for cognition were both above average with more than one standard deviation. The average of the seven-point Likert scale is 3.500, which was used for the subscales of Academic Motivation and the Five-Dimensional Curiosity Scale.

Intrinsic motivation toward knowledge, intrinsic motivation toward accomplishment and joyous exploration were more than two standard deviations from average. Intrinsic motivation to experience stimulation was more than one standard deviation from average. Deprivation sensitivity and stress tolerance are less than one standard deviation from average. One standard deviation from the mean means that 68% of the data is above the average, two standard deviations from the mean means that 95% of the data is above the average of the used Likert scale.

Table 1

Descriptive Statistics of Flow, Need for Cognition, Curiosity and Intrinsic Motivation

	Mean	Std. Deviation	Cronbach's Alpha	N of items
Flow	3.435	.510	.737	9
Joyous Exploration	5.108	.883	.769	5
Deprivation Sensitivity	4.353	1.245	.832	5
Stress Tolerance	4.360	1.256	.810	5
IM Toward knowledge	5.376	.774	.825	4
IM Toward Accomplishment	4.757	1.016	.779	4
IM to Experience Stimulation	4.113	1.233	.820	4
Need For Cognition	3.576	.623	.739	6

Note. IM = intrinsic motivation; Std. = Standard; N = Number.

Correlations

Flow is positively correlated with all the predictors (Table 2). Using Cohen's (1988) interpretation to interpret the correlations: < 0.3 is small, 0.3 - 0.5 is moderate and > 0.5 is large. All the predictors had a moderate (between r = .30 and r = .50) correlation with flow, except for deprivation sensitivity and intrinsic motivation to experience stimulation, which had small correlations (r < .30). All correlations are significant (p <.001).

Table 2

Pearson Correlation between Flow, Curiosity, Need for Cognition and Intrinsic Motivation

		Flow	JoyExp	DS	IMKno	IMAcc	IMExp	NFC	ST
Pearson Correlation	Flow	-							
	JoyExp	,325*	-						
	DS	,182*	,372*	-					
	IMKno	,406*	,599*	,612*	-				
	IMAcc	,387*	,420*	,349*	,634*	-			
	IMExp	,242*	,467*	,259*	,570*	,551*	-		
	NFC	,355*	,618*	,378*	,478*	,316*	,389*	-	
	ST	,326*	,320*	-,135**	,094***	,015***	,128**	,280*	-

Note. JoyExp = joyous exploration; DS = deprivation sensitivity; IMkno = intrinsic motivation toward knowledge; IMAcc = intrinsic motivation towards accomplishment; IMExp = intrinsic motivation to experience stimulation; NFC = need for cognition; ST = stress tolerance.

* $p < .001$. ** $p < .01$. *** $p > .03$.

To test the hypothesis that the cognitive motivation aspects are interrelated, we look at the correlation between the aspects (Table 2). The associations in question are: curiosity with intrinsic motivation, need for cognition with intrinsic motivation and need for cognition with curiosity. All correlations are significant ($p < .01$), except for the correlation between stress tolerance and both intrinsic motivation toward accomplishment ($p = .388$) and intrinsic

motivation toward knowledge (p = .035). Testing the hypothesis that curiosity positively associates with intrinsic motivation, we examine the subscales of curiosity which are all positively correlated with the subscales of intrinsic motivation, ranging from small to large correlations. This range excludes the insignificant correlations between stress tolerance correlations with intrinsic motivation toward knowledge and intrinsic motivation toward accomplishment. Need for cognition is moderately positively correlated with the intrinsic motivation subscales, and need for cognition is positively correlated with the curiosity subscales, ranging from small to large correlations.

Main Analyses

Standard multiple regression analysis was used to examine the value of need for cognition, joyous exploration, deprivation sensitivity, stress tolerance, intrinsic motivation to experience stimulation, intrinsic motivation toward accomplishment and intrinsic motivation toward knowledge to predict flow in studies. This tests the hypothesis that curiosity, need for cognition and academic intrinsic motivation predict flow in studies. The adjusted R^2 is low (R^2_{adj} = .291, $F(7, 362)$, p <.001). The model is significant ($p < 0.01$), thus the null hypothesis can be rejected and the alternative hypothesis that there is a relationship between flow and the independent variables can be accepted. 29.1% of the variation within flow in studies is being explained by the cognitive motivational aspects.

The standardized coefficient in the multiple regression that contributes the most for predicting flow is stress tolerance, then intrinsic motivation toward accomplishment, then intrinsic motivation toward knowledge and lastly need for cognition (Table 3). These coefficients are statistically significant ($p < .01$), thus the null hypothesis can be rejected and the alternative hypothesis that the coefficient is significantly different from zero can be accepted. The other coefficients were not found significant; joyous exploration, deprivation sensitivity and intrinsic motivation to experience stimulation all have a p-value > .01, which

means these are not statistically significant and indicates strong evidence for the null hypothesis; that these variables do not help predict flow in studies.

Table 3
Regression Coefficients for Predicting Flow

		Unstd. Coefficients		Std. Coefficients			95% CI for B		Correlations
Model		B	SE	Beta	t	Sig.	LB	UB	Part
1	(Constant)	1.349	,180	-	7.476	<,001	,994	11,704	-
	JoyExp	-,042	.037	,072	-1,116	,265	-,115	,032	-,049
	DS	-,017	,024	,043	-,720	,472	-,065	,030	-,032
	IMKno	,171	,050	,259	3,387	<,001	,072	,270	,148
	IMAcc	,136	,030	,271	4,542	<,001	,077	,195	,199
	IMExp	-,047	,024	,113	-1,960	0,51	-,094	,000	-,086
	NFC	,140	,048	,171	2,934	,004	,046	,234	,129
	ST	,114	,020	,281	5,695	<,001	0,75	,154	,250

Note. JoyExp = joyous exploration; DS = deprivation sensitivity; IMkno = intrinsic motivation toward knowledge; IMAcc = intrinsic motivation towards accomplishment; IMExp = intrinsic motivation to experience stimulation; NFC = need for cognition; ST = stress tolerance.

[a] Dependent Variable: flowscale.

The significant standardized regression coefficients are positive (Table 3). For every standard deviation increase in stress tolerance, there is an increase of $\beta = 0.281$ standard deviations of flow. For intrinsic motivation toward accomplishment this is a $\beta = 0.271$ increase, for intrinsic motivation toward knowledge this is a $\beta = 0.259$ increase and lastly for need for cognition this is an $\beta = 0.171$ increase.

The critical t-value is $t(368) = \pm 1.649$. Intrinsic motivation toward knowledge, intrinsic motivation toward accomplishment, need for cognition and stress tolerance's t-values are above the critical t-value, thus the null hypothesis can be rejected and the alternative hypothesis can be accepted that a difference exists between the sample sets. The t-values of the other variables were not significant, thus we cannot reject the null hypothesis that there is no difference.

Stress tolerance has the highest squared semi-partial ($sr^2 = .063$), which means 6.3% of the variance in flow is uniquely associated with stress tolerance. The second highest is intrinsic motivation toward accomplishment ($sr^2 = .040$), then intrinsic motivation toward knowledge ($sr^2 = .022$) and lastly for need for cognition ($sr^2 = .017$).

Discussion

We hypothesized that curiosity, need for cognition and intrinsic motivation predict flow in studies. Stress tolerance, intrinsic motivation toward accomplishment, intrinsic motivation toward knowledge and need for cognition were statistically significant with both the p-value and the t-value in the regression model, meaning that the variables do predict flow in studies and that there is a difference between the variables. Only 29.1% of the variation within flow in studies is being explained in this model. This is common in psychology studies as behavior differs per person.

Stress tolerance, intrinsic motivation toward accomplishment, intrinsic motivation toward knowledge and need for cognition help predict flow in studies, all with significant positive regression coefficients. Schutte and Malouff (2020) found a positive correlation between stress tolerance and flow, but the predictive value has not been recorded previously. It uniquely explains 6.3% of the variance of flow, which is the highest single-variable variance in this study, and has the highest predictive value of all predictors. A possible explanation for this could be related to one of the antecedents of flow: the balance between perceived task

demands and task skills (Barthelemäs & Keller, 2021). When the demands are higher than the skill, this disbalance causes anxiety or stress. If one's stress tolerance is high, they can tolerate this anxiety better, thus staying longer in balance. The balance stays intact for longer, which is needed to come into flow.

Intrinsic motivation toward accomplishment and intrinsic motivation toward knowledge were also found significant predictors. This was expected as Csikszentmihalyi (1975) saw flow as an intrinsically motivated state of being and a positive association has been found between flow and intrinsic motivation (Ljubin-Golub, Rijavec & Olčar, 2020). Need for cognition had the smallest predictive value, but still significant. There was little previous research but there were signs of association with flow (Juric, 2017). Intrinsic motivation toward accomplishment, intrinsic motivation toward knowledge and need for cognition could maybe help the flow antecedent of clear goals (Barthelemäs & Keller, 2021), as the goals of these variables are relatively clear: accomplish something, learn something and engage in logical thinking or problem solving.

The aspects joyous exploration, deprivation sensitivity and intrinsic motivation to experience stimulation were not statistically significant in the regression model, therefore they are not likely to help predict flow in studies. These aspects did have significant zero-order correlations with flow, thus without including the other variables they do have a positive association with flow. Previous studies show association between these variables and flow on their own: Ljubin-Golub, Rijavec & Olčar (2020) found associations between flow and intrinsic motivation, and Kashdan et al. (2009) and Schutte and Malouff (2020) found curiosity to have an association with activating or increasing flow. The reason that we have not found a predictive value for these variables, could explained by that the current study uses regression to analyze the data, which controls for the influence of other variables (unlike correlation), or that the previous studies could have been influenced by the omitted variable bias, which occurs

when a statistical model fails to include all the relevant variables. The current study takes more predictive variables into account than previous studies as need for cognition and subscales of intrinsic motivation and curiosity are taken into account to predict flow. Another explanation could be that simply, these variables only have an association with flow but do not add any predictive value.

The second hypothesis stated that the cognitive motivational aspects are associated with each other; curiosity associated with intrinsic motivation, need for cognition associated with intrinsic motivation and the need for cognition associated with curiosity. The correlations between the subscales were all significant ($p < .05$), except for stress tolerance with intrinsic motivation toward knowledge and intrinsic motivation toward knowledge. The hypothesis is confirmed that there are positive associations between the cognitive motivational aspects, as the other subclasses from curiosity and intrinsic motivation were statistically significant. This is what we expected to find, as Litman (2005) and Loewenstein (1994) concluded that curiosity is an intrinsically motivated trait, Amabile et al. (1994) found associations between need for cognition and intrinsic motivation and Olson, Camp, and Fuller (1984) found a high correlation between need for cognition and curiosity. In Olson, Camp, and Fuller (1984), seven of the eight curiosity scales were significantly correlated with the single need for cognition scale. The only non-significant scale was diverse curiosity, whose definition seems to resemble joyous exploration. This contrasts the high and significant correlation found in the current study, which can be caused by the different scale used. Both curiosity and intrinsic motivation's and curiosity and need for cognition's associations vary between small to large. Need for cognition and intrinsic motivation's association is overall moderate.

The present study has found a significant predictive model for flow in studies with stress tolerance, intrinsic motivation toward accomplishment, intrinsic motivation toward knowledge and need for cognition being significant predictors. This is the first time these

variables are put together to predict flow, while controlling for the influence of each other. Stress tolerance was the most valuable predictor, which was unexpected. Intrinsic motivation has often been associated with flow (Fong et al., 2015; Kowal & Fortier, 1999). There was less research about need for cognition with flow, although there was research that suggested associations (Juric, 2017). The predictive value these two variables have while controlling for the other variables is new information. There were significant correlations between the variables curiosity, need for cognition and intrinsic motivation as expected, except for stress tolerance and both intrinsic motivation toward accomplishment and intrinsic motivation toward knowledge. The explained variance of the model was only 29.1%, so there is much variance left to be explained.

Limitations

Our sample only has first year students from the University of Groningen psychology faculty and has a high percentage of females, which makes it difficult to generalize the results to other university students. Sex could have an effect on the experience and prediction of flow. For example, there are sex differences in need for cognition (Tanaka, Panter & Winborne, 1988; Sousa, et al. 2018). Using a sample of university undergraduate students, women consistently scored higher than men on the cognitive persistence subscale (Tanaka, Panter & Winborne, 1988), and Sausa, et al. (2018) found significant differences between the genders in the levels of need for cognition. Our sample is primarily women, so the need for cognition score might have been higher in the current study than in average university students. Using a sample that includes higher-year students and students from other faculties could remedy this problem.

The measures used and the choice to make them unidimensional or multidimensional possibly influenced the interpretation of this study. Other scales could have affected the results. The choice to look at need for cognition unidimensional could have had an impact on how we

view the results. By not including the subscales, a lot of nuance and information is not taken into account.

Variables that were not accounted for in the current study possibly influenced the results by being left out of the multiple regression, such as creativity. Earlier research has found an association between flow and creativity (Łucznik, May & Redding, 2021; Stollberger & Debus, 2020; Primus & Sonnenburg, 2018). Or, the earlier mentioned Autotelic Personality, Personality Types could also have a predictive value for flow (Tse, Nakamura & Csikszentmihalyi, 2021; Bauman, Lürig & Engeser, 2016).

Future research

Future research could replicate the findings of the current study, using a sample from a more overarching population the results would be more generalizable. In this study, stress tolerance is the largest predictor effect on flow in studies. There could be more research about the predictive nature of stress tolerance on flow to get a deeper understanding about the relation between these two concepts. Creativity and personality types could also be included in the regression model to contribute to the explained variance, as earlier research suggests they have positive associations with flow (Łucznik, May & Redding, 2021; Stollberger & Debus, 2020; Primus & Sonnenburg, 2018; Tse, Nakamura & Csikszentmihalyi, 2021; Bauman, Lürig & Engeser, 2016). The model might explain more variance with these constructs added, together with the variables from the current research.

Conclusion

In conclusion, the cognitive motivational aspects stress tolerance, intrinsic motivation toward accomplishment, intrinsic motivation toward knowledge and need for cognition are significant predictors of flow in studies, of which stress tolerance has the largest predictive value. The model is significant, though it does not explain much of the variance of the data, but this is common in psychology. This study is unique in researching the predictive value of

these cognitive aspects on flow in studies. This helps to understand and get a better insight on what the predictors of flow in studies are. As concluded in previous research, we found that there are associations between the different cognitive motivational aspects. Although some correlations were small, they were almost all significant. This replicates previous studies findings, which strengthens the theory that these aspects are associated. Future studies could use a more overarching population, focus on the nature of the relation between flow and stress tolerance and the predictive value creativity and personality types on flow.

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Appendix

Chart 1

Histogram of Regression Residuals

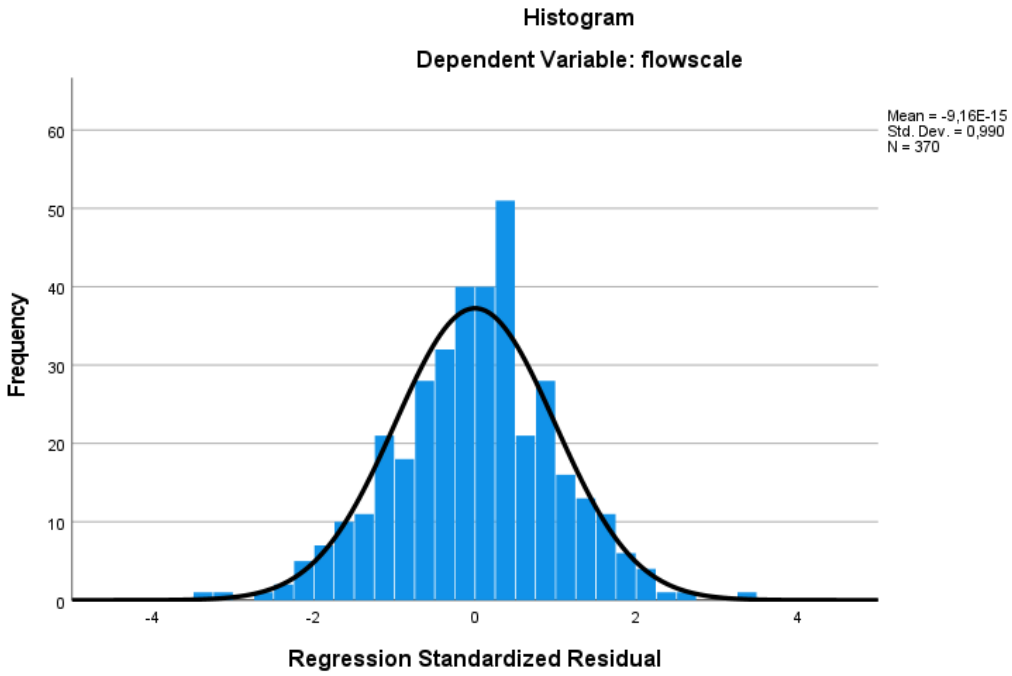

Chart 2

Residual Plot