Curiosity in Children and Adolescents

Data From the Polish Adaptation of the Need for Cognition Scale

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Abstract. This research presents data on the Polish adaptation of the Need for Cognition Scale for Children and Adolescents (Keller et al., 2016; Preckel & Strobel, 2017). Two samples of children, mostly from Grade 6 of primary school, were recruited ($N_1 = 1,001$, $N_2 = 433$), as well as one sample of 130 child–parent pairs. Confirmatory factor analysis showed that the nested factor structure suggested in previous studies (Keller et al., 2016) is also replicated in the Polish sample. Scalar measurement invariance with regard to gender has been demonstrated. Scale scores show convergent and discriminant validity with learning/performance goals as well as traits from the Big Five Questionnaire for Children (Cieciuch et al., 2016). Criterion-related validity with measures of leisure time interests in popular science, identification with science, and objectified cultural family capital is shown. Data confirm that the Polish version of the scale is suitable for use; nonetheless, some possible revisions of the scale are also discussed.

Keywords: need for cognition, investment traits, learning goals, Big Five

Cognitive effort, just like any other type of effort, is costly, and this is taken into account in human decision making. People differ in the amount of time they are willing to invest in complex, intellectual problem solving when the main reward for engagement in this activity is just knowing more or feeling less irritated by one's own information gaps (Loewenstein, 1994). These differences are relatively stable and cross-situational. Need for Cognition (NFC) is a construct which refers to such individual differences (Cacioppo & Petty, 1982). One of the important effects related to such differences is the fact that people high in NFC pay more attention to argument quality when being exposed to persuasive messages (Carpenter, 2015). This effect specifically appears under conditions in which the message is perceived as not easy to process (e.g., elaborated, complex, and dense) and not of high immediate, personal relevance (Luttrell et al., 2017; Petty & Cacioppo, 2016). Arguably, many important messages present in the current global society, politics, and economy fulfill those contextual conditions, which makes it important to understand the pathways that lead to the development of individual differences in adult NFC.

What is however currently lacking in the literature is data on the development of NFC. One of the reasons is a lack of proper assessment tools for children and adolescents. For example, the majority of studies on curiosity, a trait related to NFC, have been conducted with adults. Jirout and Klahr

(2012) list the available behavioral and questionnaire scales for curiosity and find seven adult self-reports and only two scales suitable for older, elementary school children. There is a repertoire of behavioral measures of curiosity designed for children, mostly based on spontaneous exploration, but these are necessarily resource-consuming and difficult to validate or standardize (Jirout & Klahr, 2012). Other scales use parental reports of curiosity of children, as young as 3–8 years of age, but the downside of this type of measure is the limitation of untrained and biased informants, that is parents (Piotrowski et al., 2014).

With regard to NFC, only recently, assessment instruments designed for children have been developed. Scales for children of at least 10 years of age have been developed in France (Ginet & Py, 2000) and Germany (Preckel, 2014). Another scale, NFC for Children and Adolescents (NFC-CA) created by Preckel and Strobel (2017), is of particular interest for the following reasons: (a) due to low linguistic complexity, it is suitable for children as young as Grade 1, but it can also be used with children as old as Grade 9; (b) it does not include inverted items; (c) it has already been adapted for use in Germany, Luxembourg, and Finland, which offers the possibility of cross-national multilab research (Keller et al., 2016); and (d) it is based on a recent theoretical *Intellect* model (Mussel, 2013). This last point offers the possibility of positioning the NFC

construct in a nomological net next to other similar constructs, as well as elaborating on the distinction between approaching intellectually challenging situations and sustaining the effort to overcome these challenges.

The *Intellect* Model

von Stumm and Ackerman (2013) determined that various personality traits, which refer to the amount of investment of time and effort in pursuit of knowledge, are generally positively related with adult intelligence with an average estimate of .30. While conducting this research, they have identified a total of 34 such personality constructs. Such diversity of closely related constructs is problematic since there is also evidence that at least some of them could be integrated (Mussel, 2010). Mussel (2013) offered a framework for such integration: the *Intellect* model. Intellect is defined in this model as a dispositional personality variable, which motivates behavior related to intellectual achievements. This personality variable is assumed to be complex and composed of two motivational processes and three operations. The two separate motivational processes are (1) Seek, which refers to initial preference for novelty, complexity, and ambiguity, which leads to approaching cognitive stimulation, and (2) Conquer, which refers to the subsequent stage of sustained effort while being engaged in thinking, learning, or creating. This distinction between thinking, learning, and creating is also the basis of the three separate intellectual operations in the model. Mussel (2013) separates these operations referring to known differences between fluid intelligence (Think), crystallized intelligence (Learn), and creativity (Create).

Multidimensional scaling conducted by Mussel (2013) leads to a conclusion that several existing constructs can be described using these two factors of the *Intellect* model. For example, Interest-type curiosity and Deprivation-type curiosity (Litman, 2008; Litman & Jimerson, 2004) both refer to the operation: Learn, but the former refers to the motivational process: Conquer and the latter to: Seek. The construct of Learning Goal Orientation (Dweck, 1986) can be positioned in between the processes of Seek and Conquer and operations Learn and Think (Mussel, 2013, p. 896). Importantly, from the perspective of the current study, the classic NFC construct (Cacioppo et al., 1984) is positioned within the motivational process: Seek and operation: Think (Mussel, 2013, p. 896).

NFC Scale for Children and Adolescents

Preckel and Strobel (2017) created their NFC-CA scale with reference to the *Intellect* model (Mussel, 2013), but

in their view, the definition of the NFC construct includes both motivational processes: Seeking and Conquering cognitive challenges (Keller et al., 2016, p. 2). Therefore, the scale is set to include items which tap both processes. Additionally, the scale assumes a nested factor model of the NFC construct, with three uncorrelated latent variables. There is a one general factor: Think influencing all the items and two additional factors: Seek and Conquer, which are specifically loading only those items, which clearly and specifically refer to these motivational processes. The Think factor is taken as an indicator of the general level of NFC. It has been confirmed, on several samples from Germany, Finland, and Luxembourg, that this nested structure is better fitted to data than both a single factor model and a correlated factor model (Keller et al., 2016).

Since NFC is a motivational trait which refers to the level of pleasurable intellectual investment and the use of central (vs. peripheral) information processing route, in the school setting, one can expect that high NFC will be related to the choice of more challenging tasks in the area which one specifically identifies with and derives pleasure from (Dickhäuser & Reinhard, 2009). This also results in having more precise performance expectancies in that students know, after personal investment, what they are good and what drives their curiosity (Dickhäuser & Reinhard, 2009). NFC can also overlap with general positive academic self-concept via its positive association with fluid intelligence (Fleischhauer et al., 2010).

Keller et al. (2016) have shown that the NFC-CA scale indeed displays expected correlations with academic self-concept and academic interest, as well as convergent validity with other measures, such as the NFC scale for adolescents (Preckel, 2014). NFC-CA also shows expected positive correlations with learning goals orientation, positive ability self-concept, control motivation (e.g., seeking feedback) and with academic achievement, but only in older children (Luong et al., 2017). The aim of the current study is to offer a Polish adaptation of this scale.

Study 1

Study 1 Goals

The Goals of Study 1 are to (a) perform translation of the NFC-CA scale, (b) provide large sample data to verify the structure of the translated scale using confirmatory factor analysis (CFA), and (c) test for criterion-related and convergent/discriminant validity of the scale.

Method

Participants and Procedure

The study was conducted in 2017 on a Polish community sample of 1,001 children, mostly from primary school Grade 6 (47.8% males), aged 12 (79% of the sample), $SD_{age} = 0.65$, $min_{age} = 10$, $max_{age} = 15$). Age of participants was determined by the fact that recruitment accompanied a science promotion program, a mobile exhibition from the Copernicus Science Center (Warsaw, Poland), which was directed specifically to this age group. Thirty-nine schools agreed to offer their students questionnaires from the current study. Schools volunteered for participation in the science promotion program and therefore were not randomly selected from the population. Furthermore, the sample did not include schools from the largest cities in Poland with a population above 100,000 (this constitutes 39 from a total of 923 cities in Poland), in line with the participation requirements of the science promotion program. Each school was located in a different-sized community, and this included rural areas (42% of the sample), cities with population up to 20,000 (25%), and cities with populations from 20,000 to 100,000 (32%). All the children were fluent Polish speakers.

The study was conducted in accordance with the Universal Declaration of Ethical Principles for Psychologists (Gauthier et al., 2010). Parental and student informed consent was obtained, and participation in the study was voluntary and not related to participation or lack of participation in the science promotion program. Questionnaire items were administered in a paper-and-pencil format in a classroom setting. Teachers volunteered to devote a portion of their lesson to let the students fill out the questionnaire. Data collection was anonymous.

Measures

All measures were provided in one booklet, which consisted of a title page, description of contents, and informed consent.

The NFC-CA

The scale is a self-report, 14-item measure created by Preckel and Strobel (2017). In the Polish adaptation, the answer format uses a 5-point Likert-type scale from 0 *definitely not* to 4 *definitely yes*. Visual symbolic emotional expressions of sad (0 disagreement), neutral (2 indifference), and happy (4 agreement) faces correspond with verbal labels. This answer format was adapted as a middle ground in between the variety of formats used in previous studies (Keller et al., 2016). Previous studies used a 3-point scale for younger children and either 7-point scale or 4-point scale for older children; therefore, not single format could be adapted.

Direct transcription of the original questionnaire items was performed. Contents of the questions refer mostly to basic school or leisure time activities, which are common to children living in both Germany and Poland, and therefore, no further cultural adjustment of the items was necessary (Table 1). Both the German original and English-translated items (Keller et al., 2016; Preckel & Strobel, 2017) were used as the source material to be translated by seven translators. Translators were fluent in both Polish and English, with one translator fluent in German and Polish. Discussion, which included back and forth translation, led to a selection of one version of the translation for each item that seemed most appropriate in terms of wording and clarity. Therefore, the first Polish version also included 14 items, as did the original, and no additional items were created. The scale includes only positively worded items, which prevents some methodological artifacts related to wording ambiguity (van Sonderen et al., 2013).

Demographics

Demographic questions included school location, year of birth, gender, parental education, parental occupation, and the number of books owned in the household. NFC scores should not be related to neither parental education nor location of a particular school, but should be positively related to the declared number of books in households, as this is a good proxy for objectified cultural capital (Sieben & Lechner, 2019).

Performance and Learning Goals

Convergent and discriminant validity was tested by correlating the scale score with indicators of learning and performance goal orientations. As shown by Luong et al. (2017) and predicted by the *Intellect* model (Mussel, 2013), moderate positive correlations between NFC and learning orientation can be expected, and these should be stronger than correlations between NFC and performance goals. Although neither performance nor learning goals were measured with a standard scale in Study 1, it was assumed that satisfaction derived from learning mathematics and science in school could be taken as an indicator of learning goals. Grades obtained from mathematics and science were taken as an indicator of performance goals. It was expected that the correlation between the NFC score and learning satisfaction would be higher than the correlation between NFC and declared grades.

Performance goal orientation was measured with declared final grades from last year in mathematics, Polish language, and science classes (min Grade 2, max Grade 6). Learning goals orientation was measured with declared positive affect toward learning about science and mathematics. This was measured with two direct questions: "I enjoy learning..."

Table 1. NFC-CA Scale Item Wordings in Polish and English

No.	Hypothesized factor	Polish	English
1	Think	Lubię pogłównkować, żeby znaleźć rozwiązanie jakiegoś problemu.	I like thinking to find solutions to problems.
2	Think	Myślenie sprawia mi frajdę.	Thinking is fun for me.
3	Think/Conquer	Gdy czegoś nie rozumiem, zastanawiam się nad tym tak długo, aż to zrozumiem.	When I don't understand something, I think it through until I've got it.
4	Think/Seek	Lubię rozwiązywać zadania, które wymagają ode mnie sporo myślenia.	I like to work on problems that require a lot of thinking.
5	Think/Conquer	W szkole chcę wszystko jak najdokładniej zrozumieć.	In school I want to understand everything exactly.
6	Think/Seek	Lubię dostawać pracę domową, która wymaga ode mnie dużo zastanowienia.	I like it when I get homework that I really have to chew over.
7	Think/Seek	Chętnie rozwiązuje zagadki i łamigłówki.	I like to do puzzles.
8	Think/Conquer	Zawsze chcę wszystko dokładnie zrozumieć.	I always want to know things exactly.
9	Think/Seek	Lubię zadania nad którymi muszę dobrze pomyśleć.	I like problems where I have to think a lot.
10	Think/Conquer	Lubię uczyć się nowych rzeczy.	I like learning new things.
11	Think/Seek	Lubię sytuacje, w których muszę znaleźć właściwe rozwiązanie problemu.	I like situations in which I have to think a lot.
12	Think/Seek	Gdy w szkole dostaję zadania wymagające myślenia, to sprawia mi to sporo przyjemności.	At school, when I get problems that require me to think, I'm glad.
13	Think/Seek	Lubię, gdy mogę coś osiągnąć za pomocą własnych pomysłów.	I like situations where I can accomplish something by thinking.
14	Think	Uwielbiam rozmyślać nad różnymi rzeczami.	I love thinking about things.

Note. English item content and hypothesized factor loadings from Keller et al. (2016).

The answer format used a 5-point scale: 0–4 (from *I definitely do not agree* to *I definitely do agree*).

Identification With and Interest in Science

As previous studies have shown, NFC is a predictor of a variety of everyday life situations, not necessarily related with formal academic achievement (Strobel et al., 2018). For example, in young adults, NFC predicts interest in science, over and above other personality variables (Feist, 2012). NFC also predicts critical thinking skills after controlling for general cognitive ability (West et al., 2008). It was therefore assumed that criterion-related validity for an NFC scale can be demonstrated with increased voluntary exposure to material which involves critical thinking and effortful processing. In the current study, NFC-CA was tested by correlating the scale score with attitudes toward science and amount of free time spent on various activities related to popular science.

Science Curiosity in Free Time

Leisure time investment in popular science activities was measured with 6 items: frequency of (a) watching popular science channels, (b) watching other science-related videos on television or through the internet, (c) reading science-related books or magazines, (d) reading blogs or websites

related to popular science, (e) personal engagement in science related activities (e.g., conducting homemade experiments or systematic nature observations), and (f) having conversations with others about science. Answer format: 0–4 (*never* to *almost every day*).

Identification With Science

Beliefs about importance of science and self-identification with science were measured with 9 items. Items asked about student ability self-concept in relation to science, for example, “People like me can become scientists,” or perception of usefulness of science, for example, “Knowledge gained by science is useful in everyday life.” The scale was developed as part of the evaluation of the science promotion program by the Copernicus Science Center. For the full item list, see Electronic Supplementary Material 1 (ESM 1). Responses were given on a 5-point scale: 0–4 (from *I definitely do not agree* to *I definitely agree*).

Analytic Strategy

Data were analyzed using JASP (2019). CFA was conducted following Brown (2006). The following goodness-of-fit criteria were adopted: RMSEA <.08, Tucker-Lewis index (TLI) and comparative fit index (CFI) >.90, and standardized root mean square residual (SRMR) <.08. Data

were obtained in a classroom setting and involve class-related topics, which suggests clustering of data, but the anonymity of the study rendered it impossible to describe the class of the participant. Only school-level data were available, and since all participating schools follow a similar, government-regulated curriculum, no clustering was applied to the data. Percentage of missing values for each variable was <5%. Bivariate correlations and multiple linear regression model were used to test the hypotheses.

Results

Scale Score Reliability and Fit Evaluation

NFC-CA

Keller et al. (2016) offer evidence that the scale is best modeled as a nested factor structure (Brunner et al., 2012), with three uncorrelated latent variables: one general NFC factor loading all the items (items 1–14) and two specific factors influencing some of the items, Conquer: items 3, 5, 8, 10; Seek: items 4, 6, 7, 9, 11. The same structure was tested in this CFA. Full data on parameter estimates and additional fit indices are provided in ESM 1. Model fit indices of the model were adequate with $\chi^2(66) = 234.9$, CFI = .957, TLI = .941, RMSEA (90% CI) = .051 (.044–.058), SRMR = .034. This corresponds with data (Keller et al., 2016) from Finland, Grade 6 (11–13 years), CFI = .964, RMSEA (90% CI) = .060 (.055–.066), SRMR = .028; Luxembourg, Grade 7, CFI = .986, RMSEA (90% CI) = .057 (.054–.060); and Germany, Grade 4, CFI = .979, RMSEA (90% CI) = .040 (.032–.048).

Measurement invariance was tested for groups of boys and girls. Metric and scalar invariance regarding student's gender was assessed by a criterion of less than $-.01$ change in CFI, .015 in RMSEA, and .030 in SRMR (Chen, 2007). Metric invariance for gender held as the changes in parameters were CFI = .001, RMSEA = .004, and SRMR = .013. Scalar invariance for gender also held as changes were CFI = .007, RMSEA = .002, and SRMR = .015. Percentage of missing values for each variable was less than 5% (max = 3.9% on item 12). Reliability of the general NFC factor (items 1–14) was adequate with $\omega = .865$, $\alpha = .864$ (.851–.876).

Performance Goal Orientation

Principal component analysis (PCA) with parallel analysis was used for determining an adequate number of factors (Hayton et al., 2004). PCA resulted in a one-factor solution. Grades from mathematics, Polish language, and science were combined into an average academic achievement index with the following reliability: $\omega = .877$, $\alpha = .876$ (.862–.889).

Learning Goal Orientation

Correlation between liking of mathematics and science classes was low (Pearson's $r = .23$, $p < .05$), and therefore, each variable was analyzed separately.

Identification With Science

PCA with parallel analysis was run and resulted in a one-factor solution. Reliability of the index was adequate with $\omega = .768$, $\alpha = .758$ (.735–.780).

Science Curiosity in Free Time

PCA with parallel analysis was run and resulted in a one-factor solution. Reliability of the index was adequate with $\omega = .750$, $\alpha = .740$ (.714–.764).

Demographic Data

Linear regression was run with NFC as a dependent variable and demographic data as predictors. As expected, NFC was related to the number of books in a household, $\beta = .232$, $t(964) = 7.476$, $p < .001$, but not to community size, parental education, or student's age. NFC was also predicted by gender, $\beta = .133$, $t(964) = 4.290$, $p < .001$ (female = higher NFC), and this explained a minor proportion of variance in NFC, $R^2 = .073$, $F(2, 964) = 39.21$, $p < .001$.

Learning and Performance Goals

Average student grades showed a weak, positive correlation with liking the process of learning both about nature ($r = .075$, $p < .01$) and mathematics ($r = .094$, $p < .01$). As expected, NFC showed a slightly stronger relationship with liking to learn both mathematics, $r = .35$, $p < .001$, 95% CI (.29, .4) and nature, $r = .31$, $p < .001$, 95% CI (.26, .37), than with average grades, $r = .27$, $p < .001$, 95% CI (.21, .33). However, this effect could be sample-specific as the 95% CIs of correlation parameter estimates overlap. Correlation between NFC and average grades remains identical when the average grade from the Polish language is excluded from this analysis.

Interest in Science

NFC scores show criterion-related validity: a moderately strong, positive correlation with both identification with science ($r = .497$, $p < .001$) and time spent engaging with popular science in free time ($r = .352$, $p < .001$).

Study 1 Discussion

The results of Study 1 confirm that the Polish version of the NFC-CA scale fits with the model previously confirmed with data from other countries (Keller et al., 2016). The scale shows criterion-related validity by expected positive correlations with (a) the amount of free time spent on

popular science activities, (b) identification with science, and (c) cultural capital. NFC is not related to parental education (to whether either of the parents has a university degree) or the place of living (town/city/village).

The scale also shows a positive relation with average grades from Polish language, mathematics, and science, which has been taken as an indicator of performance goals, and a positive relation with learning goals, indicated by satisfaction from learning about mathematics and nature. Current data do not enable a firm conclusion that NFC captures the motivational aspect of intellectual problem solving (subjects linking) to a larger extent than the degree to which one performs well at school-related tasks (grades). It needs to be noted however that treating grades and subjects liking as indicators of study goals is questionable. Both variables could be rather treated as criterion-related measures. Therefore, Study 2 aims at direct measurement of study goals constructs.

Study 2

Study 2 Goals

Study 1 answers the basic questions about the structure of the scale and shows criterion-related validity, but conclusive data on convergent/divergent validity are still lacking. As previously mentioned, the *Intellect* framework (Mussel, 2013) and other studies (Luong et al., 2017) suggest that NFC is positively related to the learning-goal orientation and openness to experience. Since NFC represents internal motivation, it should however be more strongly related to personal preferences for learning goals, than, for example, to the level of parental goal emphasis (Friedel et al., 2007).

NFC can also be related to perceptions of parental failure anxiety (Haimovitz & Dweck, 2016). Parental failure anxiety is visible to children, via reactions to low grades or criticism, and predicts their children's fixed intelligence mindsets (Haimovitz & Dweck, 2016). Fixed intelligence mindset is a belief that one's own cognitive ability potential is largely immutable and permanent. Having a fixed intelligence mindset is in turn correlated with low effort in dealing with complex intellectual tasks, which might question the level of a person's ability (Blackwell et al., 2007). The opposite is true for students with high NFC. High levels of NFC predict increased effort for complex tasks and decreased effort for routine tasks (Mussel et al., 2016). It is therefore expected that parental failure anxiety should be related to lower levels of children's NFC.

NFC should also share variance with traits from the Big Five personality framework, especially Openness (Mussel,

2013). Studies using NFC as measured by Cacioppo and Petty (1982) tend to show positive correlations between NFC and Openness, but also Conscientiousness and Extraversion (Tuten & Bosnjak, 2001). Other studies show a negative correlation with Neuroticism as well (Fleischhauer et al., 2010). Results are therefore mixed, and this seems to depend on whether the full facets of Big Five traits are being measured. NFC is related, for example, only to Assertiveness and Activity facets of Extraversion (Fleischhauer et al., 2010). Most data on NFC and personality factors come from student samples. It is possible that the relationship between Neuroticism and NFC is stronger in a student sample than in a sample of children because of increased complexity and stress involved in problem solving in this age group. Neuroticism, as measured in a Big Five Questionnaire (BFQ) for Children (Barbaranelli et al., 2003; Cieciuch et al., 2016), refers rather to mild tendencies to worry or experience negative affect, rather than experiencing high levels of depression and anxiety. With regard to the relationship between NFC and Openness, it should be noted that this refers especially to the *openness/intellect* construct as defined by Goldberg (1990), rather than *openness to experience* as defined by McCrae and Costa (2003). These two constructs can be distinguished on the basis of neural activity and their relationship with working memory (DeYoung et al., 2009). Only *openness/intellect* is related to working memory performance, whereas *openness to experience* is not, but rather relates to interest in art, different political orientations and cultural experiences. *Openness to experience* shares more variance than NFC with sensation seeking (Fleischhauer et al., 2010). The current study uses the BFQ for Children (Barbaranelli et al., 2003; Cieciuch et al., 2016), which defines the *openness/intellect* construct closer to the approach suggested by Goldberg (1990); therefore, a strong relationship to NFC is expected. When considering the two specific factors of NFC-CA: Seek and Conquer, by definition, the former should show a stronger relationship to Openness, whereas the latter should show a stronger relationship to Conscientiousness from the Big Five framework (Mussel, 2013).

Method

Participants and Procedure

Study 2 was conducted with two, newly recruited, community samples with a total of N of 433. Schools for Study 2 were recruited via mail sent out to personnel of primary schools in Poland. Materials for the first sample, $n = 303$, 49.2% females, $M_{age} = 11.86$, $SD_{age} = 1.4$, $min_{age} = 9$, $max_{age} = 17$, were administered online and filled out in a classroom setting in an IT classroom. First sample completed NFC-CA and BGQ. The second sample

included 130 adolescent-parent pairs, with 51.5% adolescent females, $M_{age} = 10.5$, $SD_{age} = 1.9$, $min_{age} = 7$, $max_{age} = 14$. Gender of parents was not measured, and the primary caregiver filled out questionnaires. Students completed measures (paper-and-pencil) in a classroom setting. Parents received questionnaires to fill out at home. The study was conducted in accordance with the Universal Declaration of Ethical Principles for Psychologists (Gauthier et al., 2010). Parental and student informed consent was obtained. No personal data were collected. Students from the second sample completed NFC-CA, BFQ, and Performance and Learning Goals Scale. Parents from the second sample completed the Performance and Learning Goals Scale and Failure Anxiety Scale.

Measures

Measures for the first sample were provided online and for the second sample in one booklet, which consisted of a title page, description of contents, and informed consent.

NFC-CA

Scale matched the instrument used in Study 1.

Big Five Questionnaire for Children

The BFQ (Ciecuch et al., 2016) is a 65-item self-report measure of Big Five personality traits adapted for use with people aged 7–15. Answer format uses a 5-point scale: 0–4 (*almost never to almost always*).

Performance and Learning Goals

Performance and learning goals were measured with four scales: learning goals scale (6 items) and performance goals scale (6 items) with separate versions for both the parents and the children. Items were adapted from the Patterns of Adaptive Learning Survey (PALS) (Friedel et al., 2007). Items for parents ask about their preferences regarding their children's goals. Items for children ask about their own preferences and what they think the parents would prefer. For a full item list, check ESM 1. Sample items: for *Parental Performance Goals*, "I like it when others see that my child is getting good grades in class," *Child Performance Goals* "During the lesson, I care about doing better than other students," *Parental Learning Goals* "I would like my child to understand what is being said in class, and not just to do the tasks correctly," *Child Learning Goals*, "It is important for me to understand well what I learn in class." Items are evaluated on a Likert-type scale from 1 *strongly disagree* to 5 *strongly agree*.

Parental Failure Anxiety

Failure mindsets of parents were evaluated with 4 items from Haimovitz and Dweck (2016), for example,

"Admitting defeat spoils your opinion." Items are evaluated on a Likert-type scale from 1 *strongly disagree* to 5 *strongly agree*.

Analytic Strategy

Data were analyzed using JASP (2019). For the first sample, there were no missing data as the scale was administered online and the system verified whether participants filled out all the necessary information. For the second sample, max missing data were 6.9% in one variable. Both samples were combined for the analysis of the NFC/Big Five relationships. Data on NFC and learning goals were available only for the second sample. The multiple linear regression model was used to test the hypotheses.

Results

Big Five

Scale score reliability was for Extraversion $\omega = .714$, $\alpha = .711$ (.668–.749), Neuroticism $\omega = .847$, $\alpha = .840$ (.817–.860), Openness $\omega = .786$, $\alpha = .782$ (.750–.811), Conscientiousness $\omega = .847$, $\alpha = .843$ (.820–.863), and Agreeableness $\omega = .848$, $\alpha = .848$ (.826–.868). Linear regression with NFC as the dependent variable and Big Five traits as covariates was run to check the expected relationship between NFC and Openness while controlling for other traits. Collinearity diagnostic results are acceptable (Hutcheson & Sofroniou, 1999) with highest VIF obtained for Conscientiousness = 2.083. Main NFC factor score was not related to Extraversion, $\beta = -.041$, $t(426) = -.944$, $p = .346$, Neuroticism, $\beta = -.004$, $t(426) = -.099$, $p = .921$, nor Agreeableness, $\beta = .1$, $t(426) = 1.888$, $p = .06$, but predicted by Openness, $\beta = .277$, $t(426) = 5.444$, $p < .001$, and Conscientiousness, $\beta = .356$, $t(426) = 6.517$, $p < .001$, which explained a significant proportion of variance in NFC, $R^2 = .381$, $F(5, 426) = 54.111$, $p < .001$. Similar regression was run for the specific Seek factor (items 4, 6, 7, 9, 11). Seek was not related to Extraversion, $\beta = -.008$, $t(426) = -.174$, $p = .862$, Neuroticism, $\beta = -.02$, $t(426) = -.484$, $p = .629$, nor Agreeableness, $\beta = .084$, $t(426) = 1.499$, $p = .135$, but predicted by Openness, $\beta = .262$, $t(426) = 4.863$, $p < .001$, and Conscientiousness, $\beta = .293$, $t(426) = 5.048$, $p < .001$, which explained a significant proportion of variance, $R^2 = .304$, $F(5, 426) = 38.569$, $p < .001$. For the specific Conquer factor (items 3, 5, 8, 10), Openness offered a weaker predictive value, $\beta = .152$, $t(426) = 2.887$, $p < .01$, than Conscientiousness, $\beta = .471$, $t(426) = 8.303$, $p < .001$, with $R^2 = .333$, $F(5, 426) = 44.008$, $p < .001$. Extraversion, $\beta = -.083$, $t(426) = -1.842$, $p = -.066$, Neuroticism, $\beta = -.004$, $t(426) = -.092$, $p = .927$, and Agreeableness, $\beta = .052$, $t(426) = .948$, $p = .344$, were not significant predictors of the Conquer factor.

Performance/Learning Goals and Failure Anxiety

Scale score reliability was adequate with *Parental Performance Goals*: $\omega = .767$, $\alpha = .762$ (.725–.795), *Child Performance Goals*: $\omega = .689$, $\alpha = .683$ (.634–.727), *Parental Learning Goals*: $\omega = .716$, $\alpha = .638$ (.582–.688), *Child Learning Goals*: $\omega = .732$, $\alpha = .719$ (.676–.758), and *Parental Failure Anxiety*: $\omega = .616$, $\alpha = .607$ (.542–.664). Performance and Learning Goals as declared by the parents and their children did not show strong overlap, with $r = .213$, $p < .05$ for Parent–Child Performance Goal match and $r = .171$, $p = .057$, for Parent–Child Learning Goal match. This was somewhat surprising since items of Parental Learning Goals explicitly asked about preferred learning goals for the child and items from Child Learning Goals asked both for child's own perspective and their view of parental preferences. In summary, what children believe that parents prefer did not greatly match with what the parents actually preferred. Parental Failure Anxiety was negatively related to Parental Learning Goals, $r = -.230$, $p < .01$, and positively related to Parental Performance Goals, $r = .181$, $p < .05$. Parents who show a high fear of failure tend to also focus on performance goals rather than learning goals. Parental Failure Anxiety is positively related to Child Performance Goals, $r = .197$, $p < .05$, but not to Child Learning Goals, $r = .079$, $p = .382$.

In order to test for the expected relationship between NFC and Performance/Learning goals, a linear regression with NFC as the dependent variable and Parental/Child Learning/Performance Goals, as well as Failure Anxiety, as predictors was run. The results showed that NFC was solely predicted by Child Learning Goals, $\beta = .511$, $t(119) = 6.118$, $p < .001$, with $R^2 = .254$, $F(5, 119) = 9.454$, $p < .001$. Both parental preference for Learning or Performance Goals and Failure Anxiety did not predict NFC, nor did the level of Child Performance Goals.

Study 2 Discussion

The results of Study 2 show that NFC is specifically related to the learning goals of children and not to their performance goals, nor parental preferences for learning or performance goals. This confirms that the scale measures a motivational trait, related to preference for personal improvement rather than for achieving social status or acceptance.

The lack of a relationship between children's NFC and parental failure anxiety can possibly be explained by inadequate power of Study 2 to test for this distant relationship. The link between preferences declared by parents' and children's actual preferences as well as their perception of parental preferences turned out to be weak ($r = \sim .2$). This suggests that parental failure anxiety might not always be

plainly visible to children (Haimovitz & Dweck, 2016) or that admitting to a failure anxiety attitude is biased by social desirability, even if children do experience criticism in response to social comparisons. Further studies should verify whether the relationship between the teacher's failure anxiety and children's NFC is more substantial. This is likely as children have many opportunities to observe teachers' reactions to academic failure.

As expected on the basis of theory and previous studies, NFC is positively related to Openness and Conscientiousness. It does not show a significant relationship to the level of Extraversion nor Neuroticism, which suggests that, at least in children of age ~ 12 , moderate differences in extraversion and neuroticism are not related to preferences for complex problem solving. This might be due to the fact that majority of the problem solving experiences are mandatory, as part of the school curriculum, and therefore not prohibited by social anxiety nor enhanced by sociability.

The specific Seek factor shows the same pattern of relationships with the Big Five factors as the full NFC scale. This is understandable since the analysis by (Mussel, 2013) suggests that the classical NFC scale (Cacioppo & Petty, 1982) is biased toward the Seek motivational process. The specific Conquer factor however shows a stronger bias toward Conscientiousness. Again, this is the expected result as authors of the NFC-CA scale defined this construct as being in between both motivational processes of the *Intellect* model.

General Discussion

Study 1 has shown that the Polish adaptation of the NFC-CA scale fits within the nested-factor structure established in the original version of the scale (Keller et al., 2016; Preckel & Strobel, 2017) and shows adequate psychometric properties. Study 2 has shown that NFC is positively related to the children learning goals. When considering criteria related to NFC, the scale score predicts whether a 12-year-old will be interested in science, will spend leisure time for activities related to science, and will consider them as a person who can continue on to university-level education and pursue a career as a scientist. It also corresponds with the general household cultural capital, but not with a measure of parental formal education. If one considers grades and subjects liking as proper validity criteria, then results of Study 1 offer this evidence as well.

Parental beliefs about the appropriate learning goals do not correspond with their children's NFC. The scale shows the expected pattern of correlations with the Big Five personality measure, that is, positive correlations only with Openness and Conscientiousness.

Study Limitations

An important limitation of the study is related to the relatively narrow age group of the children who participated in studies. The NFC-CA scale has been previously shown to be applicable to children as young as Grade 1 and as old as Grade 9, whereas in the current study the majority of participants were aged 12. This limitation stems from the framework of the science promotion program which enabled large-scale data collection in Study 1. Future studies should examine the validity of the scale in younger children (Grade 1+).

Second limitation lies with the fact that the study used self-reports, and therefore, there is the question of social desirability in responding. It has already been mentioned that this might have affected parental responses in relation to failure anxiety or preferred learning goals of their children. When it comes to children's responding however, social desirability seems not to have been a major factor due to the fact that (a) the study was anonymous and students were aware that the teachers will not be able to see their answers; (b) NFC did not show a correlation with Agreeableness. Existence of such a correlation might suggest that students are conforming to the expectation of a "good, curious pupil." Nonetheless, it cannot be excluded that such factors played a role.

Third limitation is the sample size in Study 2, especially the number ($N = 130$) of adolescent-parent pairs. This might have prevented establishing relationships between parental practices/beliefs and NFC in their children, if those relationships are more subtle than expected.

Final limitation concerns the general, nested structure of the NFC-CA scale. The structure assumes the existence of a general factor Think, which influences all the items, and two specific factors Seek and Conquer, which influence only a subset of items (Keller et al., 2016). Seek describes the process of searching for and approaching intellectually challenging situations, and Conquer refers to effort and persistence in closing the knowledge gaps. Thinking refers to using the above-mentioned processes in reasoning, drawing conclusions from premises, or recognizing relations between elements and not, for example, in the creation of novel and useful products (Create). When considering this, it seems that the current nested structure does not ideally fit with the *Intellect* framework. Think operation is just a context in which the two motivational processes are performed and it is hard to imagine what motivates this intellectual problem solving if not either Seeking or Conquering challenges. Likely interpretation of the current model is that the items which load the NFC main factor, but not any of the specific factors, are just not specific enough to allow for a finer distinction between the two motivational processes. The task of creating new

items, which would clearly distinguish between the motivational processes, which differ just in temporal order, might not be easy though. For example, the item "I like it when I get homework that I really have to chew over." refers to (a) anticipation of pleasure from a new cognitive task which indicates Seek and (b) subsequent effortful goal pursuit which indicates Conquer. Empirical data confirm those observations, as some of the estimates of the specific factors are low (see ESM 1). This is the case of items 3 and 10 for the Conquer factor and 7 and 11 for the Seek factor. Eliminating the items with low estimates from those factors does not seem reasonable however, because it would leave the specific Conquer factor with a problematically low set of only 2 items (Brown, 2006). It can be suggested that the future revisions of the scale should attempt to more closely delineate between motivational processes, but as for now the scale can serve as a good indicator of general NFC in children and adolescents.

Conclusion

Two studies have shown that the Polish adaptation of the NFC-CA scale shows psychometric properties comparable with the original version and can be considered for use in subsequent studies which could verify the cross-cultural invariance of this construct.

Electronic Supplementary Material

The electronic supplementary material is available with the online version of the article at <https://doi.org/10.1027/2698-1866/a000007>

ESM 1. Data from the Polish Adaptation of the Need for Cognition Scale

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History

Received April 7, 2020

Revision received January 30, 2021

Accepted February 4, 2021

Published online March 31, 2021

Section: Differential Psychology

Acknowledgments

The author wishes to thank Katarzyna Potęga vel Żabik, Maria Mathia, Dorota Dąbrowska, Aleksandra Plewka, Aleksandra Sutkowska, Angelika Ochendowska, Gabriela Uberta, Hubert Sutkowski, Joanna Olejniczak, Katarzyna Wisiecka, Mateusz Nowakowski, Anna Puchtafor, Marek Muszyński, Dr. Ilona Iłowiecka-Tańska, Dr. Katarzyna Pobiega, and Dr. Katarzyna Winkowska-Nowak for support in data collection and manuscript preparation.

Open Data

Data available from the author upon request.

Funding

Part of this research was supported by a grant 1/2016/FRBN-CNK from the SWPS University of Social Sciences and Humanities Research Development Fund and the Research Department of the Copernicus Science Center in Warsaw. Data collection for Study 1 was possible, thanks to the NAUKOBUS program managed by the Copernicus Science Center in Warsaw and financed by the Ministry of Science and Higher Education in Poland.

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