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Does Need for Cognition Have the Same Meaning at Different Ages?

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Abstract

Determining whether Need for Cognition (NC) has the same meaning across age may help understand why there are dramatically different age trends for cognitive abilities and for NC in adulthood. Data from 5,004 participants aged between 18 and 99 years were used to examine both internal relations and external relations of NC. Internal relations were investigated with measures of reliability, examination of factor invariance, and test–retest coefficients across three age groups. External relations were investigated by examining relations of NC with cognitive abilities, engagement, personality, self-rated cognition, and affect. Results suggest that NC may be a broad construct that could reflect motivation to seek out intellectual challenge. In addition, examination of both internal and external relations of NC indicated that the meaning of the construct may be the same across the life span. Finally, the current article showed that the strongest predictor of NC was Openness to Experience, at any age.

Keywords

Need for Cognition, age, invariance, cognition, engagement, openness to experience, negative affect

Need for Cognition (NC) is a theoretical construct introduced by Cacioppo and Petty (1982) as a dispositional motivation to seek out intellectual challenge (Petty & Cacioppo, 1986). It is assumed to reflect stable individual differences in the intrinsic motivation to engage in and enjoy effortful cognitive endeavors (Cacioppo, Petty, Feinstein, & Jarvis, 1996), such as those required when deliberating, abstract thinking, and problem solving. An individual's NC is assessed by his or her responses to items such as "I would prefer complex to simple problems" and "I really enjoy a task that involves coming up with new solutions to problems."

Previous studies have reported dramatically different adult age trends for NC and for measures of cognitive abilities. For example, little or no age differences in NC have been found at different ages (e.g., Blanchard-Fields, Hertzog, Stein, & Pak, 2001; Cacioppo et al., 1996; von Stumm, 2012; see Cacioppo et al., 1996, for a review), whereas strong negative relations are often found with measures of cognitive abilities (e.g., Salthouse, 2009; Schaie, 2005). To illustrate, in the current sample the age correlations were −.41, for memory; −.60, for speed; −.44, for reasoning; and −.44, for space; but only −.06, for NC. Figure 1 portrays the age trends in the four cognitive abilities and NC.

The different age trends in NC and in cognitive abilities are surprising because there have been several reports of positive associations between level of NC and level of cognitive abilities (e.g., Bors, Vigneau, & Lalande, 2006; Fleischhauer et al., 2010; Hill et al., 2013; Soubelet & Salthouse, 2010; von Stumm, 2012; von Stumm & Ackerman, 2013). One possible explanation for the different age trends for NC and for cognitive abilities is that the meaning of NC is not the same at different periods of adulthood. For example, it is possible that the lack of mean age trend in NC occurs because NC reflects motivation to engage in stimulating activities only at younger ages while it reflects social desirability at older ages. In this case, age-related differences in motivation to engage in cognitive activities may be obscured. That is, if NC reflects social desirability at older ages, it is possible that NC scores at older ages are similar to those of younger people even if older people have lower motivation to engage in cognitively stimulating activities than younger people.

A measure might have different meaning at different ages either because of internal characteristics, such as item reliability or factor structure, or because of external relations, such as correlations with other variables. A shift in the internal structure of the scale could occur if the items do not represent the same factors to the same extent at different ages. For example, NC might reflect motivation to engage

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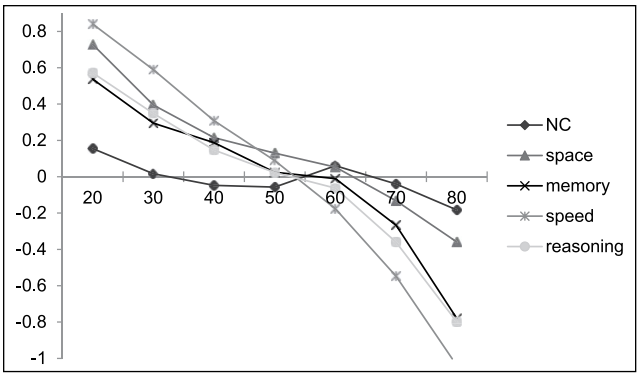

Figure 1. Age trends for four cognitive abilities and for Need for Cognition (NC; *N* = 5,004).

in stimulating activities at younger ages, and reactions to anxiety and depression at older ages. Patterns of relations with other variables are also informative about the meaning of a scale, and whether the scale reflects the same construct(s) at different ages. For example, if NC reflects perceived cognitive decline to a greater extent at older ages than at younger ages, one might expect a stronger relation of NC with self-rated cognitive decline at older ages than at younger ages. Alternatively, if responses to NC items are more influenced by a positive self-presentation bias in older adults than in young adults, one might expect stronger relations of NC with measures of social desirability at older ages than at younger ages.

Previous research has investigated internal structure and external correlates of NC. Recent work on internal structure of the 18-item NC scale has supported that multidimensionality found in the scale was due to item-polarity effects. For example, Forsterlee and Ho (1999) have reported a two-factor solution: Factor 1 comprised all the positively worded items and Factor 2 comprised the negatively worded items. Bors et al. (2006) have identified three factors: one trait factor common to all items and two uncorrelated method factors, based on the wording polarity of items. Hevey et al. (2012) have tested several models and have shown that the unidimensional model with correlated errors among the negatively worded items was the best solution. Furnham and Thorne (2013) have found the 18-item scale to reflect one dominant factor, once reworded the negative-polarity items of the scale. However, analyses of the internal structure of the NC scale have been conducted on samples of young ages and there is no available information on whether the internal structure of the scale is similar at different ages.

Previous examinations of external correlates of NC have shown that higher levels of NC were associated with higher levels of cognitive abilities (e.g., Bors et al., 2006; Fleischhauer et al., 2010; Hill et al., 2013; Salthouse, 2014; Soubelet & Salthouse, 2011; von Stumm, 2012; von Stumm & Ackerman, 2013), higher levels of engagement in activities (e.g., von Stumm, 2012; see however Soubelet & Salthouse, 2011), higher levels of education (see Cacioppo et al., 1996, for review), higher levels of Openness to Experience (e.g., Berzonsky & Sullivan, 1992; Fleischhauer et al., 2010; Soubelet & Salthouse, 2011), higher levels of Conscientiousness (e.g., Fleischhauer et al., 2010) and lower levels of Neuroticism (Dornic, Ekehammar, & Laaksonen, 1991; Fleischhauer et al., 2010). Unfortunately, there has been no investigation on whether correlates of NC are age invariant. It is therefore unknown whether the meaning of NC is the same at different periods of adulthood.

The Present Study

The goal of the current project was to investigate whether the meaning of NC was the same at different periods of adulthood. Both internal and external relations were examined. With respect to internal relations, although there have been several reports that the 18-item version of the NC scale reflects two dimensions distinguished by the wording of the items (e.g., Bors et al., 2006; Forsterlee & Ho, 1999; Furnham & Thorne, 2013; Hevey et al., 2012), it is not known whether the dimensionality of the scale is similar at different periods of adulthood. With respect to external relations, correlations of NC with other measures were examined to determine whether the pattern of correlates differed as a function of age. For example, NC may be more strongly related to perceived cognitive decline at older ages than at younger ages if perception of cognitive decline leads people to increase their motivation to engage in complex activities (and hence their scores on NC) to minimize further decline. Alternatively, because NC is assessed with self-reports whose validity has been found to be influenced by social desirability bias (e.g., Bäckström, Björklund, & Larsson, 2009; DeYoung, Peterson, & Higgins, 2002; Edwards, 1966; Konstabel, Aavik, & Allik, 2006; see also Kuncel & Tellegen, 2009), and because social desirability has been found higher at older ages than at younger ages (Soubelet & Salthouse, 2011), another possibility is that NC is more closely related to social desirability at older ages than at younger ages.

A total of 5,004 participants between 18 and 99 years of age completed the 18-item version of the NC scale (Cacioppo et al., 1996), together with several measures of cognitive abilities, personality, activity engagement, self-rated cognition and cognitive decline, and negative affect. To investigate the meaning of NC across ages, we explored internal structure and external correlates of the 18-item version of the NC scale. Internal relations were investigated with measures of reliability, examination of factor invariance, and test–retest coefficients across three age groups. External relations were investigated by examining relations of NC with cognitive abilities, personality traits, engagement in activities, self-rated cognition, and negative affect.

Table 1. Descriptive Characteristics of the Sample by Age Range.

	18-39 Years	40-59 Years	60-99 Years	Age *r*
N	1,381	1,921	1,702	
Age	27.2 (6.2)	50.6 (4.2)	70.5 (7.9)	
Female (%)	62.0	70.7	60.7	
Self-rated health	2.0 (0.9)	2.2 (0.9)	2.3 (0.9)	.13*
Activity limitation	1.4 (0.7)	1.7 (1.0)	1.9 (1.0)	.25*
Years of education	15.1 (2.4)	15.5 (2.7)	16.2 (2.9)	.17*
Age-adjusted scaled scores				
Vocabulary	12.5 (3.5)	11.6 (3.3)	13.0 (2.8)	.05*
Digit symbol	11.1 (3.0)	11.0 (3.0)	11.4 (2.8)	.07*
Logical memory	11.4 (3.0)	11.3 (3.2)	12.0 (3.1)	.06*
Word recall	11.9 (3.1)	11.7 (3.5)	12.1 (3.3)	.00

Note. Standard deviations are in parentheses. Self-rated health is assessed with a 5-point scale ranging from 1 (*excellent*) to 5 (*poor*). Activity limitation is assessed with a scale ranging from 1 (*very little*) to 5 (*very much*). Age-adjusted scaled scores are based on the nationally representative normative samples from the Wechsler Adult Intelligence Scale–Third edition (Wechsler, 1997a) and the Wechsler Memory Scale–Third edition (Wechsler, 1997b) in which the means are 10 and the standard deviations are 3.
*$p < .01$.

Of particular interest was evidence of differential relations at different ages, in the form of interactions of age with external variables in the prediction of NC.

Method

Participants

Five thousand and four participants were recruited through newspaper advertisements, flyers, and referrals from other participants. Descriptive characteristics of the sample are provided in Table 1. The mean age of the participants was 50.9 years (*SD* = 18.2), with 64.9% of women. Most of the participants were highly educated, with a mean of 15.6 years of formal education, and healthy, with a mean of about 2.2 on a self-report health scale ranging from 1 (*excellent*) to 5 (*poor*). Approximately 81% of the participants were Caucasian, about 11% African American, and the remainder distributed across other ethnicities or reporting more than one ethnicity.

Because both the cognitive tests described below and the Wechsler Adult Intelligence Scale IV (WAIS-IV) test battery were administered to 90 adults between 20 and 80 years of age, it was possible to estimate WAIS full-scale IQ scores from the cognitive scores for all participants. The estimation procedure has been described elsewhere (Salthouse, 2014). The mean IQ was 109 (*SD* = 14).

As a means of evaluating the representativeness of the sample, age-adjusted scaled scores are provided for four tests from the WAIS-III (Wechsler, 1997a) and the Wechsler Memory Scale III (Wechsler, 1997b). The small positive relations of age to the age-adjusted scaled scores for the four cognitive variables suggests that if anything, the older adults in the sample were higher functioning relative to their age peers than young adults.

Procedure

Participants were administered several cognitive tests in the laboratory by trained research assistants. Questionnaires were completed by the participants at home.

Measures

Cognitive Tests. The cognitive tests were designed to assess inductive reasoning with tests of reasoning and spatial visualization, vocabulary, Episodic Memory with verbal memory tests, and Perceptual Speed with substitution and comparison tests. Reasoning was assessed with Ravens' Matrices (Raven, 1962), Shipley's Abstraction (Zachary, 1986), and Letter sets (Ekstrom, French, Harman, & Dermen, 1976). Spatial visualization was assessed with Spatial relations (Bennett, Seashore, & Wesman, 1997), Paper Folding (Ekstrom et al., 1976) and Form Boards (Ekstrom et al., 1976). Vocabulary was assessed with WAIS vocabulary (Wechsler, 1997a), Picture vocabulary (Woodcock & Johnson, 1989), Antonym vocabulary (Salthouse, 1993a, 1993b, 1993c), and Synonym vocabulary (Salthouse, 1993a, 1993b, 1993c). Episodic Memory was assessed with Logical Memory (Wechsler, 1997b), Free recall (Wechsler, 1997b), and Paired associates (Salthouse, Fristoe, & Rhee, 1996; Salthouse, Hambrick, Lukas, & Dell, 1996; Salthouse, Hancock, Meinz, & Hambrick, 1996) tests. Speed was assessed with Digit Symbol (Wechsler, 1997a), Letter Comparison (Salthouse & Babcock, 1991), and Pattern Comparison (Salthouse & Babcock, 1991) tests. (Descriptions of the tests are contained in Salthouse [2004] and Salthouse, Pink, and Tucker-Drob [2008].) Many of the participants also completed the *North American Adult Reading Test* (Uttl, 2002).

Need for Cognition (Cacioppo et al., 1996). The shortened 18-item version of the Need for Cognition scale was used. Because some participants returned for a second occasion, we examined test–retest coefficients of NC at different ages to determine whether NC scores showed more stability at some ages than at others. Intertest intervals varied between 2 months and 13.08 years, with a mean of 2.93 years and a standard deviation of 1.68 years.

Estimated IQ. Because both the cognitive tests described above and the WAIS-IV test battery were administered to 90 adults between 20 and 80 years of age, it was possible to estimate WAIS full-scale IQ scores from the cognitive scores for all participants. The estimation procedure has been described elsewhere (Salthouse, 2014).

Activity Inventory. The Activity Inventory (Salthouse, Berish, & Miles, 2002) contains 22 activities. For each activity, the participant was asked to report the number of hours spent engaged in the activity during a typical week. Furthermore, for activities with at least some reported engagement, the participants also rated the cognitive demands of the activity, on a 5-point scale ranging from 1 (*absolutely no cognitive demands*) to 5 (*high cognitive demands*). Because people with higher levels of NC are expected to have spent more hours engaged in cognitively stimulating activities, the sum of hours participants reported spent engaged in all activities was used in the current project. In addition, because people with higher NC levels are expected to involve in more complex thinking, the relation between level of NC and average of cognitive demands rated for all activities were examined in the current project.

Personality Inventory. The participants completed the 50-item version of the Big-Five 5 Broad Domains (from the International Personality Item Pool; 50-item version; Goldberg, 1992, 1999), which provided estimates of five personality traits (emotional stability, extraversion, openness, agreeableness, and conscientiousness).

Social Desirability. The Need for Approval Scale (Crowne & Marlowe, 1960) was administered to assess social desirability. This scale consists of 33 true or false statements to which the participants indicated whether they agreed or not. Items in the scale relate to behaviors that are "culturally sanctioned or approved but which are improbable of occurrence" (Crowne & Marlowe, 1960, p. 350). Examples of items are "I have never deliberately said something that hurt someone's feelings" or "I have never been irked when people expressed ideas very different from my own."

Dysexecutive Questionnaire (DEX; Wilson, Alderman, Burgess, Emslie, & Evans, 1996). The DEX is a self-reported 20-item questionnaire that assesses four dimensions associated with executive difficulties: emotional and personality changes (e.g., "I have difficulty showing emotion"), motivational changes (e.g., "I seem lethargic and unenthusiastic about things"), behavioral changes (e.g., "I act without thinking, doing the first thing that comes to mind"), and cognitive changes (e.g., "I have difficulty thinking ahead or planning for the future"). Each item is scored on a 5-point Likert-type scale ranging from 0 (*never*) to 4 (*very often*). The items were reverse-coded, so that higher scores indicate better self-reported functioning.

Cognitive Complaints. Cognitive complaints were assessed with five items. Three items were from the General Frequency Forgetting subscale from the Memory Functioning Questionnaire (MFQ; Gilewski, Zelinski, & Schaie, 1990): "In general, as compared with the average individual, how would you describe your memory?" "How would you describe your memory, on the whole, compared with the best it has ever been?" and "How would you rate your memory in terms of the kinds of problems that you have?" Two items were developed locally to evaluate thinking and reasoning abilities. Participants were asked to rate their thinking and reasoning abilities relative to earlier in life and in terms of problems in day-to-day life. All items were rated on 7-point scales in which "1" indicated *poorer functioning* and "7" indicated *better functioning*. A composite variable which included ratings of memory and ratings of thinking and reasoning was computed.

Specific Memory Problems. Six scores relative to memory problems were computed from the MFQ (Gilewski et al., 1990). The first score represented general frequency of forgetting and was assessed with 18 items such as "How often do names present a problem for you?" or "How often do directions to places present a problem for you?" The second score represented having trouble remembering what the individual has read in a novel and was assessed with five items such as "As you are reading a novel, how often do you have trouble remembering what you have read in the opening chapters, once you have finished the book?" or "As you are reading a novel, how often do you have trouble remembering what you have read the sentence before the one you are currently reading?" The third score represented having trouble remembering what has been read in a newspaper or magazine article, and was assessed with five items such as "When you are reading a newspaper or magazine article, how often do you have trouble remembering what you have read in the opening paragraphs, once you have finished the article?" The fourth score concerned how well the individual remembers things that occurred past month, between 6 months and 1 year ago, between 1 and 5 years ago, and between 6 and 10 years ago. The fifth score evaluated how serious the individual consider memory failures to be, with 18 items such as "When you actually forget [names], how serious of a problem do you consider the memory failure to be?" Finally, the sixth score evaluated retrospective functioning. Participants were asked to rate their memory compared with the way it was *1 year ago*, *5 years ago*, *10 years ago*, *20 years ago*, and when they were 18 years. All items were rated on 7-point scales, with "1" indicating *poorer functioning* and "7" indicating *better functioning*.

Negative Affect. Measures of negative affect or mood included the Center for Epidemiological Studies–Depression

Scale (Radloff, 1977); the State-Trait Anxiety Inventory (Spielberger, Gorsush, Lushene, Vagg, & Jacobs, 1983); and the Negative Affect Scale from the Positive and Negative Affect Scale (Watson, Clark, & Tellegen, 1988). A composite variable of Negative Affect which included z scores of the three measures of negative affect was computed.

Statistical Analysis

Internal relations of the NC scale were examined with several types of analyses. First, reliability of the scale was examined with Cronbach's alpha coefficients. Second, the factorial structure of the NC scale was examined by means of an exploratory analysis with Promax rotation. This statistical analysis was conducted using IBM SPSS (version 21). Several confirmatory factor analyses (CFAs) were next conducted with Amos 21.0 (Arbuckle, 2012). Covariance matrices were used as input for maximum likelihood method of estimation procedures. Models were evaluated using the comparative fit index (CFI) and the root mean square error of approximation (RMSEA). Indices greater than .90 for CFI and lower than .08 for RMSEA are generally interpreted as indicating acceptable fit (Bentler, 1990; Bollen, 1989; Browne & Cudeck, 1993). Third, to determine if models were equivalent across age, multigroup invariance of CFA models was conducted. Five degrees of invariance with increasingly severe across-group restrictions on parameters were tested. The first degree of invariance we examined was configural invariance. In this analysis, factor means were set to 0, while the factor loadings, the factor variances, and the factor covariances were freely estimated in each group. Configural invariance suggests that the same latent variable (or variables) are present in different age groups. The next level of invariance we tested was metric invariance. This type of invariance assumes configural invariance and adds the additional constraint of invariant factor loadings over age groups. This is considered weak measurement invariance. If factor loading invariance is established, it suggests that the age groups have the same unit of measurement. We next examined scalar invariance that is the hypothesis that intercepts linking the observed items to the latent factors were constant across age groups. This test of invariance presumes both configural and metric invariance. Presence of both factor loading invariance and intercept invariance is considered strong measurement invariance. The fourth level of invariance we tested was the structural covariances invariance. This type of invariance assumes that both factor variances and covariances are similar across age groups. Finally, we examined strict invariance, which supposed that residual variances of measured variables are equal across age groups.

Because chi-square tests are sensitive to sample size (Brown, 2006), some authors have criticized the single use of the χ^2 difference value and recommended the use of other fit indices, namely, the CFI difference to evaluate measurement invariance. In the current project, we used both χ^2 differences and CFI differences to make decisions on models equivalence. CFI differences lower than or equal to .01 suggest equivalence (Bentler, 1990; Cheung & Rensvold, 2002; Medsker, Williams, & Holahan, 1994).

A second major phase to our analyses consisted of examining external relations of NC. Predictors of NC were tested with multiple regression analyses conducted with IBM SPSS (version 21). All variables included in regression models were first centered. Interactions between age and each predictor were tested, by entering the cross-product term of age with the predictor in regression models. Three types on analyses were conducted. First, we examined predictors of NC independently. Because predictors were not independent of one another, we next investigated specific relations of predictors with NC by including predictors of NC which were part of a same category (e.g., personality traits) simultaneously. And third, we investigated specific relations of predictors with NC by including simultaneously all predictors in a multiple regression analysis.

Because of the large number of statistical comparisons, a significance level of .01 was used in all statistical tests.

Results

Internal Reliability Analysis and Factorial Analyses

First, because we were interested in age relations, we divided our sample into three age groups that approximately corresponded to the periods of young adulthood (18-39 years), middle adulthood (40-59 years), and older adulthood (60-99 years). Reliability was examined with coefficient alpha in each age group. The values were .89, .90, and .89, in the 18 to 39, 40 to 59, and 60 to 99 age groups, respectively. These values suggest that reliability was high, but coefficient alphas are based on the assumption of a unitary scale, and therefore, factor analyses were conducted to test whether the items reflect a unitary psychological dimension.

Three different factorial structures were examined with CFAs. They were compared across the three age groups to determine whether it is reasonable to assume that it is invariant across age groups. The first structure was based on an exploratory analysis with Promax rotation. All positively worded items had moderate to strong loadings (>.63) on Factor 1, while all negatively worded items had moderate to strong loadings (>.49) on Factor 2. This factorial structure is consistent with reports of a two-factor structure associated with the polarity of the items (e.g., Furnham & Thorne, 2013; Hevey et al., 2012).

Table 2. Fit Indices for Models.

Model #	Model description	χ^2	*df*	χ^2/df	CFI	RMSEA [90% CI]
1	Two-factor correlated (positive vs. negative wording)	1518.303	134	11.331	.949	.045 [.043, .047]
2	One factor-correlated errors (based on wording)	960.346	99	9.700	.968	.042 [.039, .044]
3	Two-factor correlated (based on age effects)	3189.616	134	23.803	.888	.067 [.065, .069]

Note. χ^2 = adjusted chi-square fit statistic; *df* = degrees of freedom; RMSEA = root mean square error of approximation; CFI = comparative fit index; CI = confidence interval.

The second structure was a unidimensional model with correlated errors among the negatively worded items (Hevey et al., 2012). This model differs from Model 1 by postulating a single dimension with relations among negatively worded items accommodated by correlations among the items instead of with a distinct factor.

The third structure postulated two factors based on the magnitude of age correlations on individual items. Factor 1 was defined by items which correlated with age and Factor 2 was defined by items which did not correlate with age.

The goodness-of-fit of the models was evaluated using the chi-square test. For absolute model fit, the CFI and the RMSEA are also reported. We calculated 90% RMSEA confidence intervals (CIs) for the models estimated (MacCallum, Browne, & Sugawara, 1996). Values of the CFI above .90 suggest a well-fitting model, while values less than .08 for the RMSEA indicate an acceptable model fit (cf. Browne & Cudeck, 1993). Fit indices are reported in Table 2. The best solutions were found to be Models 1 and 2, which both assume that multidimensionality in the NC scale is explained by polarity items. Model 2, which assumes unidimensionality of the scale, and accounts for the wording effects by correlating errors of the items, was slightly better that Model 1.

Measurement Invariance

To determine whether the three models were age invariant, we examined different degrees of invariance by employing multiple-group confirmatory models with increasingly severe across-group restrictions on parameters (see the Statistical Analysis section). Fit indices are reported in Table 3. Whatever the factorial structure examined, strong invariance was supported, as there was evidence for configural invariance, metric invariance, scalar invariance, and structural covariances invariance. However, strict invariance was not fully established because constraining error variances of observed variables to be equal across age groups slightly altered CFI.

Finally, test–retest stability coefficients were examined across age groups. They were similar across the age groups (r = .76*, in the younger group; r = .76*, in the middle-age group; and r = .75*, in the older group [* means p<.01]). Test–retest stability coefficients were the same before and after controlling for test–retest interval in each age group.

To summarize, several sets of results were consistent with the idea that NC had similar internal relations across ages. That is, estimates of internal consistency and test–retest reliability were similar across age groups, and there was evidence for strong invariance of the NC measurement across ages.

External Relations of NC

The initial regression analyses considered each predictor variable separately, along with age, and the interaction of the predictor with age. In order to minimize collinearity between the predictor and the age × predictor interaction, all variables were centered before multiplying them with age to create an age × predictor interaction term. Results of these analyses are reported in the left panel of Table 4.

It can be seen that higher levels of NC were associated with higher levels of cognitive abilities and estimated IQ, higher levels of education, more time spent engaged in cognitive activities, higher levels of positive personality traits (emotional stability, extraversion, openness to experience, agreeableness, and conscientiousness), higher levels of self-rated cognition, and lower levels of negative affect. People with higher levels of NC also rated activities they engage in as more cognitively demanding than people with lower levels of NC. Only occupational status and social desirability were not related to NC.

In addition, the absence of significant interactions indicates that this pattern of results was similar at different ages, except for DEX, Negative Affect, the sum of hours people reported spending engaged in cognitive activities and the average-rated cognitive demands. The interaction of age with DEX indicated that the relation between DEX and NC was stronger at older ages than at younger ages, in the direction of lower NC for people who reported more executive difficulties (higher scores on DEX). The interaction of age with Negative Affect indicated that the negative relation between Negative Affect and NC was stronger at older ages than at younger ages. The interaction of age with Cognitive Activities indicated that the positive relation between engagement in activities and NC was stronger at older ages than at younger ages. Finally, the interaction of age with Cognitive Demands indicated that the positive relation between ratings of Cognitive Demands and NC was stronger at older ages than at younger ages. Although these

Table 3. Fit Statistics for Multigroup Confirmatory Factor Models.

	χ^2	*df*	χ^2/df	RMSEA [90% CI]	CFI	ΔCFI	Δ*df*
Model 1 (Two factors based on wording)							
Single group							
18-39 Years old group	625.954	134	4.671	.052 [.047, .056]	.933		
40-59 Years old group	724.787	134	5.409	.048 [.045, .051]	.946		
60-99 Years old group	640.495	134	4.780	.047 [.043, .051]	.945		
Measurement invariance							
Configural invariance	1991.249	402	4.953	.028 [.027, .029]	.942		
Metric invariance (factor loadings)	2080.191	434	4.793	.028 [.026, .029]	.940	.002	32
Scalar invariance (intercepts)	2311.662	470	4.918	.028 [.027, .029]	.933	.009	68
Structural covariances (factor variances and covariances)	2344.829	476	4.926	.027 [.027, .029]	.932	.010	74
Strict invariance (invariance of residual variances of measured variables)	2480.285	512	4.844	.027 [.027, .029]	.928	.014	110
Model 2 (one factor, correlated errors based on wording)							
Single group							
18-39 Years old group	410.485	99	4.146	.048 [.043, .053]	.957		
40-59 Years old group	460.386	99	4.650	.044 [.040, .048]	.967		
60-99 Years old group	430.517	99	4.349	.044 [.040, .049]	.964		
Measurement invariance							
Configural invariance	1301.398	297	4.382	.026 [.025, .027]	.963		
Metric invariance (factor loadings)	1405.739	331	4.247	.025 [.025, .027]	.961	.002	34
Scalar invariance (intercepts)	1638.076	367	4.463	.026 [.025, .028]	.954	.009	70
Structural covariances (factor variances and covariances)	1642.858	369	4.452	.026 [.025, .028]	.954	.009	72
Strict invariance (invariance of residual variances of measured variables)	1922.550	477	4.031	.025 [.023, .026]	.947	.016	180
Model 3 (two factors, age effects)							
Single group							
18-39 Years old group	944.340	134	7.047	.066 [.062, .070]	.889		
40-59 Years old group	1342.732	134	10.020	.069 [.065, .072]	.890		
60-99 Years old group	1387.691	134	10.356	.074 [.071, .078]	.864		
Measurement invariance							
Configural invariance	3674.761	402	9.141	.040 [.039, .042]	.881		
Metric invariance (factor loadings)	3755.021	434	8.752	.039 [.038, .040]	.879	.002	32
Scalar invariance (intercepts)	3983.037	470	8.475	.039 [.038, .040]	.872	.009	68
Structural covariances (factor variances and covariances)	3993.131	476	8.389	.038 [.037, .040]	.872	.009	74
Strict invariance (invariance of residual variances of measured variables)	4150.931	512	8.107	.038 [.037, .039]	.868	.013	110

Note. χ^2 = adjusted chi-square fit statistic; *df* = degrees of freedom; RMSEA = root mean square error of approximation; CFI = comparative fit index; CI = confidence interval.

interactions were significant, it is important to note that they were associated with very small R^2 increments (.002 and .003).

Because the predictors may not have been independent of one another, we next investigated specific relations of predictors with NC by including predictors of NC which were part of the same category (i.e., cognition, personality, engagement, and self-rated cognition) simultaneously in a multiple regression analysis. These results are reported in the middle panel of Table 4. Note that when all cognitive variables are included as predictors of NC, only spatial ability and vocabulary significantly predict NC, in the direction of higher levels of spatial and vocabulary abilities for people with higher levels of NC. In the regression model with all personality variables included as predictors, only Openness to Experience and Emotional Stability were significantly associated with NC, in the direction of higher levels of Openness and Emotional Stability for people with higher levels of NC. In the model which included engagement variables, higher levels of education, higher levels of cognitive demands rated on activities people engage in, and a greater number spent engaged in activities were associated with higher levels of NC. Finally, in the model which included indicators of self-rated cognition and negative affect, lower negative affect, better self-rated cognition, lower reported executive difficulties, and better ratings of

Table 4. Standardized Coefficients for Predictors (P) of Need for Cognition When Variables With Each Category Were Considered Independently, Simultaneously Within, and Simultaneously Across Categories.

	Independently		Simultaneously within category		Simultaneously across categories	
	P	P × Age	P	P × Age	P	P × Age
Cognitive variables						
Space	.39*	.02	.20*	−.03	.00	.13
Vocabulary	.38*	−.01	.26*	−.04	−.08	−.19
Reasoning	.38*	−.01	.04	.09	−.13	−.01
Est. IQ	.36*	.02	−.03	.02	.32	.12
NAART	.33*	−.01	.02	.04	−.12	−.17
Memory	.29*	.05	−.04	−.05	−.04	.13
Speed	.27*	−.02	.06	−.02	.08	−.22
Personality variables						
Openness	.60*	.00	.59*	.03	.53*	.09
Emotional Stability	.18*	.04	.12*	.04	.02	−.03
Agreeableness	.17*	−.01	−.03	−.03	−.06	.06
Extraversion	.14*	.01	−.01	−.03	−.06	−.08
Conscientiousness	.13*	.03	.04	−.03	.00	.03
Social Desirability	.05	−.01	.02	.02	−.04	.03
Engagement						
Education	.34*	.00	.31*	−.01	.11	.09
Cognitive demands	.12*	.06*	.09*	.04	.00	−.04
Cognitive activity	.10*	.06*	.09*	−.06	.06	−.01
Occupation	.03	.01	.03	.03	−.05	.04
Self-rated cognition and affect						
MFQ Novel Forget	.28*	.02	−.01	−.01	−.06	.09
MFQ News Forget	.27*	.02	−.01	−.01	.11	−.17
Cognitive Complaints	.26*	.02	.17*	.06	.16	−.10
DEX	.25*	.05*	.09*	.03	.14	.04
MFQ Freq. Forget	.22*	.02	−.02	.02	.02	−.05
Negative Affect	−.22*	−.05*	−.06*	−.01	−.09	.00
MFQ Rem. Past	.21*	.02	.06*	−.06*	−.09	.15
MFQ Memory/Past	.13*	.01	−.06*	−.01	.00	.01
MFQ Serious Forget	.08*	.01	−.04	.00	−.01	−.03

Note. Est. IQ = estimated Intellectual Quotient; NAART = North American Adult Reading Test; MFQ Novel Forget = MFQ scale assessing troubles remembering what the individual has read in a novel; MFQ News Forget = MFQ scale assessing troubles remembering what has been read in a newspaper or magazine article; DEX = Dysexecutive Questionnaire; MFQ Freq. Forget = MFQ scale assesing the general frequency of forgetting; MFQ Rem. Past = MFQ scale assessing how well the individual remembers things that occurred at different periods in the past; MFQ Memory/Past = how the individual rates her or his memory compared with the way it was at different periods of the past; MFQ Serious Forget = assessed how serious the individual considers her or his memory failures to be. Within each category of variables, predictors were ordered in decreasing magnitude of standardized (absolute) coefficient when considered independently.

memory for things that occurred in the past were associated with higher levels of NC. One indicator of self-rated memory, which assessed how the individual rated her or his memory compared with the way it was at different periods of her or his life, was negatively related to NC. That is, people who reported worse memory functioning compared with the way it was showed higher levels of NC.

Once again, the lack of age × predictor interactions indicates that these patterns of results were age invariant, except for the relation between remembering things that occurred in the past and NC. There was a significant interaction of age with this latter indicator, suggesting that there was a stronger relation between self-ratings of memory for things that occurred in the past and NC was stronger in older adults than in younger adults.

Finally, because predictors of different categories may not have been independent of one another, we also investigated specific relations of predictors with NC by simultaneously including all predictors in a multiple regression analysis. The results from these analyses are reported in the right panel of Table 4, where it can be seen that the only significant predictor of NC was Openness to Experience. In addition, because there was no significant interaction of age with Openness, the results suggest that the relation of

Openness with NC was the same at different periods of adulthood.

Discussion

Previous studies have found dramatically different trends across adulthood for NC and for measures of cognitive abilities, which is intriguing because the two constructs are positively correlated with one another. One possible interpretation for the different age trends is that the meaning of NC is not the same at different periods of adulthood. The goal of the current project was to examine this hypothesis with data from a moderately large sample of participants, covering a wide age range, who each completed the 18-item version of the NC scale as well as several measures of cognitive functioning, and questionnaires assessing engagement, personality, self-rated cognition, and negative affect.

One major finding of the project was the discovery of positive correlations between NC and a broad array of characteristics. For example, people with higher levels of NC had higher levels of cognitive functioning, and also exhibited higher levels of the personality traits of Openness to Experience, Emotional Stability, Agreeableness, Conscientiousness, and Extraversion. There were also positive correlations of NC with self-reported engagement in cognitive activities, and self-ratings of memory and thinking abilities.

In accordance with theoretical proposals (Cacioppo & Petty, 1982; Petty & Cacioppo, 1986), these relations were all consistent with the idea that NC may be a broad construct that could reflect motivation to seek out intellectual challenge and to engage in cognitively complex activities. To illustrate, positive relations of NC with self-ratings of memory and thinking abilities may reflect that a certain level of rating of memory and thinking abilities may be a prerequisite to make decisions to engage in cognitively challenging activities.

In addition, our results on both internal structure and external correlates were consistent with previous reports. Consistent with Hevey et al.'s (2012) work on the internal structure of the scale, the current data were best described by a one-factor model which included correlated errors of the items to account for the wording effects. This result indicates that the NC scale is unidimensional, and that multidimensionality previously found may be explained by wording effects. Consistent with previous reports (see Bors et al., 2006; Cacioppo et al., 1996; Fleischhauer et al., 2010; Hill et al., 2013; Salthouse, 2014; Soubelet & Salthouse, 2010; von Stumm, 2012; von Stumm & Ackerman, 2013), results on external correlates showed that higher NC are related to higher levels of cognition, openness to experience, engagement in activities, education, emotional stability and conscientiousness, and with lower levels of negative affect. There was also no relation with social desirability.

However, as noted above, the primary goal of the study was to investigate whether the meaning of NC was similar across ages. Several sets of results suggest that the answer to this question is Yes. First, there was no evidence of age differences in the reliability of the scale, the factorial structure of the scale, or the test–retest stability of NC scores, which suggest that internal relations of the scale were similar across age. And second, adults of different ages had very similar relations between NC and several other measures of cognitive functioning, activity engagement, personality, self-rated cognition, and negative affect. That is, there were no interaction of age with cognitive abilities, estimated IQ, scores on NAART (North American Adult Reading Test), personality traits, social desirability, education, occupation, MFQ scores, and with a composite measure of memory and thinking and reasoning complaints in the prediction of NC. The relations of NC with all these predictors can therefore be presumed to be nearly equivalent across ages. Interactions of age were significant with cognitive demands, cognitive activity, DEX scores, and negative affect, which could reflect different relations of the predictor to NC at different ages. However, all of the interaction effects were very small, and the interactions were not significant in analyses in which the predictors were examined simultaneously.

Because predictors may not be independent from one another, and in order to determine which of them had unique contributions to NC, we next conducted two sets of analyses. First, we examined which predictors within the same category (i.e., cognition, personality, engagement, and self-rated cognition) had unique relations with NC. And second, we investigated unique relations of all predictors (across categories) when they were all considered simultaneously. The results of these analyses revealed that many of the relations with NC were reduced when predictors within the same category were considered simultaneously. For example, among cognitive abilities, only space and vocabulary abilities significantly predicted NC; and among personality traits, only Openness to Experience and Emotional Stability had unique contributions to NC. Furthermore, when all of the predictors were examined simultaneously only Openness to Experience was a significant predictor of NC. This result is consistent with earlier reports of strong correlations between NC and Openness (e.g., Fleischhauer et al., 2010; Soubelet & Salthouse, 2010).

The present results indicate that the different age trends of NC versus cognitive abilities cannot be explained by age differences in the meaning of NC, and it therefore remains to explain why there are different age trends for NC and for cognitive abilities. One possible interpretation is that methodologies used to quantify NC and cognitive abilities are drastically different. NC scores are based on self-reports, while cognitive abilities are assessed via performance on psychometric tests. Self-reported NC therefore assesses respondents' perceptions of their NC. Respondents' perceptions of their need

for cognition appear rather the same at different ages. However, these perceptions may differ from the respondent's actual behaviors in terms of seeking out for cognitive stimulation. One possible direction in future research may be to assess NC through relatives' reports as it has previously be done in the Big-Five personality area (e.g., McCrae & Costa, 1987) and to compare age trends in this measure of NC with age trends in cognition. Another possible interpretation for the different age trends for NC and for cognitive abilities is that NC actually reflects the tendency to seek out for cognitive stimulation across adulthood but that cognitive stimulation is not efficient enough to moderate age differences in cognition.

By providing evidence for NC to reflect the same meaning at different ages, these findings have implications for researchers interested in personality but also for researchers in other areas, such as those interested in aging and development more broadly, cognition or openness, and for clinical situations. For people interested in cognition, this work provides convincing argument that the relations between NC and cognitive variables are the same at different periods of adulthood, that although all cognitive domains correlated with NC when examined separately, a few of them—space and vocabulary abilities—have unique predictive variance when examined simultaneously, and finally, that cognition is not related to NC when other personality predictors are considered. For people interested in aging, it is to note that, although NC may contribute to explain people's level in cognition, personality, engagement, self-rated cognition, and affect, this research provides evidence that NC is not a good candidate to explain age-related differences in these variables. Finally, for clinical situations, the current results indicate that the 18-item version of the NC scale can be used to assess people's tendency to seek out for cognitive stimulation or challenges, whatever the patient's or participant's chronological age.

The current study has some limitations. First, although multiple measures of cognitive, personality, engagement, self-rated cognition, and negative affect were available, the assessment of social desirability scale was relatively narrow and could have been broader with alternative measures (e.g., Balanced Inventory of Desirable Responding Scale; Paulhus, 1998). Second, most of the participants were healthy, and it is possible that different patterns of results would be found in diseases affecting cognition such as dementia. And third, the data used in the current project are correlational, and therefore do not support strong causal inferences.

However, to the best of our knowledge, there have not been any prior studies in which the meaning of NC across age has been investigated. Furthermore, this study has a number of strenghts, including a moderately large sample size, with powerful analyses and fairly precise estimates of the relevant relations. Because the sample size was over 5,000 for the total sample, and over 1,300 for each age group, it provided sufficient power to examine moderate- and small-effect sizes. In addition, most theoretical constructs were assessed with several measures, resulting in a broader assessment of the construct.

To summarize, the current project suggests that NC is a personality trait which is related to a broad array of characterics, that is, cognitive abilities, personality traits, engagement, self-rated cognition, and negative affect. Consistent with theoretical proposals, results suggest that NC may be a broad construct that could reflect motivation to seek out intellectual challenge and to engage in cognitively complex activities. In addition, examination of both internal and external relations of NC indicated that the meaning of the construct may be the same across the life span. Finally, there was evidence in the current project that the strongest predictor of NC was Openness to Experience, at any age.

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