Method Effects and the Need for Cognition Scale

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Abstract

Individual differences in the need for cognition are typically assessed using the 18-item Need for cognition scale (NCS) developed by Cacioppo and Petty (1982). However, in contrast to the unidimensional model proposed by the scale developers, recent factor analyses have produced two- and three-dimensional models of the scale. Confirmatory factor analyses were used in this study to evaluate different measurement models based on data provided by 590 (236 males, 354 females) young adult members of the general public. Although some alternative models showed promise, a single factor model with method effects associated with positively and negatively worded items provided best fit. Implications for the assessment of need for cognition are considered.

Keywords: Need for Cognition; Confirmatory Factor Analysis; Method effects

Introduction

Need for cognition refers to an individual's tendency to engage in and enjoy effortful cognitive endeavours (Cacioppo, Petty, & Kao, 1984). The term need for cognition originated in Cohen and colleagues' early work on individual differences in cognitive motivation (Cohen, 1957; Cohen, Stotland, & Wolfe, 1955). Since then research has extensively documented how need for cognition influences various cognitive and behaviour factors, including attending to, elaborating, evaluating, and recalling information (see Petty, Briñol, Loersch, & McCaslin, 2009 for a review). In relation to problem solving and decision making, those high in need for cognition think more about available options prior to making a decision and are more likely to seek additional information before coming to a decision (Petty et al., 2009). Furthermore, those who are high in need for cognition not only engage in more thinking, but are also more aware of their thinking and are more likely to evaluate their thoughts for validity (Petty, Brinol, & Tormala, 2002). Similarly, individuals high in need for cognition are more influenced by the quality of arguments concerning persuasive message processing (e. g., Haugtvedt, Petty, & Cacioppo, 1992) and show better recall and recognition

performance (e. g., Kardash & Noel, 2000). Likewise, they actively search for new information (e. g., Verplanken, Hazenberg, & Palenéwen, 1992), prefer complex to simple tasks (Cacioppo & Petty, 1982), and show better performance in cognitive exercises, such as text comprehension (Dai & Wang, 2006) or adaptive decision making (e. g., Levin, Huneke, & Jasper, 2000).

Cacioppo and Petty (1982) described it as a stable individual difference and developed a scale for its assessment. Principal-components analysis (PCA) and a Scree test revealed one dominant factor in a 34 item Need for Cognition Scale (NCS) (Cacioppo & Petty, 1982). Cacioppo et al. (1984) subsequently reduced the NCS to18 items, based on those items with the highest factor loadings; PCA of these 18 items extracted a single dominant factor that explained 37% of the variance, with a high level of internal consistency (Cronbach's alpha = .90). Half of the items reflect a preference for effortful cognitive endeavours (e. g., "I would prefer complex to simple problems"), whereas the remaining items reflect the absence of such a preference (e. g., "I only think as hard as I have to") and such items are reverse coded in the calculation of the overall scale score. Since the publication of the NCS, it has received widespread use (see Cacioppo, Petty, Feinstein, & Jarvis, 1996 for a review).

A number of authors have supported a unidimensional model (e. g., Dornic, Ekehammar, & Laaksonen, 1991; Sadowski, 1993). The single factor model has been widely endorsed on the basis of the large component that emerges from PCA and the high Cronbach's alpha: the overwhelming majority of studies in Cacioppo et al.'s (1996) review present such data. However, there are a number of potential psychometric issues requiring consideration in relation to the NCS.

A number of commentators (e. g., Fabrigar, Wegener, MacCallum, & Strahan, 1999) have raised concerns over the use of PCA as a means of identifying underlying latent variables that account for variation in observed variables. The common factor model partitions variance into common variance (the variance accounted for the common factors) and unique variance (the variance not accounted for by the common factors), which is further subdivided into specific variance (variance specific to a particular observed variable) and error variance (random variance). Common factor analysis (e. g., Principal Axis Factoring) quantifies both common and unique variance, explicitly quantifying the presence of error. In contrast PCA yields composite variables (components) that account for a mixture of common and unique sources of variance (including random error). As PCA does not model error variance, the interpretation of components may be problematic (Preacher & MacCallum, 2003). PCA partitions the total variance (the sum of variances for the original variables) by first finding the linear combination of the variables which accounts for the largest possible amount of variance. Hence it is common in PCA for the first component to be relatively larger compared to the subsequent components extracted. Of note, the criteria used by Cacioppo et al., 1984 to argue for a single factor included the observation that the first extracted factor explained a comparatively large proportion of the variance in the items. Many of the authors reporting PCA have found two factors (e. g., Sadowski, 1993) but have only focused on the size of the first component as justification for the single-factor model.

In addition, although a unidimensional scale may have a high Cronbach's alpha, a high Cronbach's alpha does not imply a single underlying factor. For example Cortina (1993) demonstrated that high alpha can emerge from a scale comprising three orthogonal subscales. Thus alpha cannot used to draw conclusion about dimensionality of a scale. Schmitt (1996) argues that alpha is not an appropriate index of unidimensionality to assess homogeneity.

Given the limitations associated with PCA and Cronbach's alpha, a number of commentators have suggested alternative approaches to assessing unidimensionality of psychological measures. To overcome problems associated with PCA, Fabrigar, Wegener, MacCallum, and Strahan (1999) argued that if data are relatively normally distributed, maximum likelihood is optimal as a wide range of indexes of the goodness of fit of the model can be examined, statistical significance testing of factor loadings and correlations among factors can be performed and confidence intervals can be computed. They note that if the assumption of multivariate normality is severely violated then one of the principal factor methods (e.g., principal axis factoring (PAF)) is recommended. In general, ML or PAF are considered robust alternatives to PCA (Costello & Osborne, 2005). Alternatives to Cronbach's alpha that can determined from a single test administration include the greatest lower bound (glb, e. g., Bentler & Woodward, 1980), which has been recommended as the optimal measures of lower bound (see Sijtsma, 2009). Cortina (1993) suggested that in addition to reporting alpha, researchers should also report the precision of alpha, a statistic that reflects the spread of interitem correlations. As Schmitt (1996) notes, Cortina's index is not the standard error of alpha as the absence of sample size in his formula means sampling error does not necessarily influence this index; Feldt (1980) presented a formula for the computation of the standard error of alpha. When assessing the degree to which a measure is actually unidimensional, rather than relying on alpha, an alternative approach is to test whether the interitem correlation matrix fits a single-factor model (Miller, 1995; Shevlin, Miles, Davies, & Walker, 2000). More recently structural equation modelling approaches to estimating reliability have been advocated (e. g., Yang & Green, 2011).

Although the majority of studies report a single factor solution (e. g., Culhane, Morera, & Hosch, 2004) for the NCS, other factor structures have been proposed. Tanaka, Panter, and Winborne (1988) argued for the existence of three factors: cognitive persistence, cognitive complexity and cognitive confidence. Tanaka et al. (1988) administered the 45-item pool from which Cacioppo and Petty (1982) developed the original 34-item NCS to samples of 288 undergraduates (Study 1) and 130 undergraduates (Study 2). Tanaka et al. (1988) reported that three factors accounted for 25% of the total observed variance and that the internal consistency of these three factors was satisfactory in both studies (Cronbach alphas ranged from .57 to .72). Waters and Zakrajsek (1990) reported acceptable internal consistencies among the three subscales identified by Tanaka et al.

In a study using the NCS-18, Stark, Bentley, Lowther, and Shaw (1991) combined responses to the 9 items that are reverse scored into one scale and treated the responses to the 9 items that are not reverse scored as a second scale. They reported that factor analyses of each of these scales yielded one factor and that the Cronbach alphas for these 9-point scales were .81 and .83, respectively. However, Stark et al did not report a factor analysis on the 18 items to support 2 factors. Of note, Forsterlee and Ho (1999) performed PCA followed by oblique rotation on the 18-item NFC and they reported a two factor solution: factor 1 comprised all the positively phrased items and factor 2 comprised the negatively phrased items. The correlation between factors was high ($r = -.52$). Vigneau and Lalande (as cited in Bors, Vigneau, & Lalande, 2006) also reported a two-factor model to reflect the positive and negative polarity items. However, these two factors may not represent substantive meaningful constructs but rather may be an artefact of method effects caused by mixing positive and negatively phrased items.

The use of negative phrased items in many scales was intended to control for response bias effects such as acquiescence (e. g. Nunnally, 1967) and was based on the assumption that positively and negatively phrased words measure the same construct; however, a number of criticisms of mixing positively and negatively phrased items have been made. Benson and Hocaevar, (1985) reported that means, variances and factor structures can be different for positive and negatively phrased items. Schriesheim and Hill (1981) reported that negatively phrased items are less reliable, especially when they are mixed with positively phrased items: such poor reliability may increase overall measurement error in the total scores. Responses to positively worded items may be more straightforward than responses to negatively worded items because of differences in semantic complexity, which may result in greater measurement error among the negative phrased items (Hankins, 2008). Method effects are systematic variance that is attributable to the measurement method rather than to the constructs the measures represent (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Research on method effects associated with items that are reverse coded indicates that reverse coding effects are present to a large extent in many measures (Magazine, Williams, & Williams, 1996). Marsh (1986) claimed that method effects are primarily associated with negatively worded items.

Given the discrepancies between the findings in relation to the underlying factor structure and the potential for response bias due to negatively phrased items, the present study examines the factor structure of the widely used NCS. A number of competing factor models are tested using confirmatory factor analysis.

Method
Participants

After receiving institutional ethical approval, convenience sampling was used to recruit 590 (236 males, 354 females; M_{age} = 20.5 years, SD = 3) members of the general public in Ireland. Approximately 2/3 were currently third-level students. Recruitment took place in various locations around Ireland (e.g. schools, sports clubs, colleges, train stations). A script was used to ensure that all participants were approached in the same way.

Measures

The first section of the questionnaire recorded demographic details such as age, gender, occupation and education. Section 2 consisted of the NCS (Cacioppo, Petty, & Kao, 1984). The 18-item measure asks participants to indicate whether or not each statement is characteristic of them on a scale of 0 ("extremely unlike me") to 4 ("extremely like me"). Higher scores on the scale represent more favourable attitudes towards cognitive effort, with a possible range from 0-72.

Data Analysis

Confirmatory factor analyses were conducted to test the following models:
   a) Cacioppo et al.'s (1984) unidimensional factor model, which assumes that the NCS assesses a single construct.
   a) A undimensional model with correlated errors among the negatively worded items, which assumes that the measure assesses a single construct but that

response bias produces correlated uniquenesses among residual variances for
the negatively worded items.
b) Forsterlee and Ho's (1999) two factor model, which assumes that the NCS
comprises two distinct factors: factor 1 comprising of all the positively phrased
items and factor 2 comprising the negatively phrased items.
c) Tanaka et al.'s (1988) three factor model, which assumes that the NCS assesses
three constructs: cognitive persistence, cognitive complexity and cognitive
confidence.

Confirmatory factor analysis was conducted using AMOS 16 (SPSS Inc.
Chicago, Illinois 60606, US). The chi-square index is inadequate as a stand alone fit
index because of its sensitivity to both small and large sample sizes (Bentler & Bonett,
1980) and therefore a variety of fit indices were used to evaluate the hypothesised factor
models (Jackson, Gillaspy, & Purc-Stephenson, 2009). The standardised root mean
square residual (SRMR), which quantifies the mean absolute value of the correlation
residuals, is also reported; lower values indicate better model fit, with values below 0.05
indicating good model fit. Furthermore, model fit was examined in relation to the
goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), normed fit index
(NFI) and comparative fir index (CFI), which all approach 1 for a perfect model fit.
Values around 0.95 of higher are typically taken to indicate good fit of the model to the
data (Hu & Bentler, 1999). The root mean square error of approximation (RMSEA) is
a parsimony adjusted index that corrects for model complexity and should be lower
than 0.05 to indicate a close approximate fit (Hu & Bentler, 1999).

Results

The results of the CFA analyses are presented in Table 1. The original
unidimensional model and the three factor model of Tanka et al. (1988) model showed
relatively poor fit to the data. The two-dimensional model based on positive and
negative items showed acceptable fit. However, the undimensional model with
correlated errors had the best fit: the model had an SRMR below .03, a GFI of .978, a
CFI of 0.987, and RMSEA = .003.

Table 1
Goodness-of-Fit Indices for NCS Models

Model	χ^2 (df)	SRMR	GFI	AGFI	NFI	CFI	RMSEA (90%CI)
Unidimensional[1]	474.4 (135)	0.063	0.863	0.827	0.781	0.833	0.080 (0.07-0.09)
Unidimensional, correlated errors	**186.1 (99)**	**0.024**	**0.978**	**0.945**	**0.957**	**0.987**	**0.032 (0.01-0.05)**
Two factors:[2] Positive items Negative items	315.2 (134)	0.059	0.916	0.893	0.856	0.911	0.060 (0.05-0.07)
Three factors:[3] Persistence Complexity Confidence	261.1 (74)	0.0578	0.907	0.858	0.835	0.874	0.082 (0.07-0.09)

Note: [1] Cacioppo et al.'s (1984) unidimensional factor model; [2] Forsterlee and Ho's (1999) two
dimensional response format model; [3] Tanaka et al.'s (1988) three factor model.

In line with recommendations (e. g., DiStefano & Hess, 2005) we report the items, their scoring, factor loadings (with standard errors) and item-total correlations for the unidimensional correlated errors model in Table 2. Figure 1 (in the Appendix) presents the observed parameters for the unidimensional model with correlated errors. With the exception of item 18, all items had factor loadings higher than .40. Similarly, item-total correlations were generally above .40. Reliability analyses revealed that the unidmensional model had the highest level of internal consistency (Cronbach's α = 0.89). Acceptable reliabilities were found for the two dimensional model: positive items (α = 0.83) and negative items (α = 0.78); however the reliability values for the three factors from Tanaka et al.'s (1988) model were more varied: persistence (α = 0.77, complexity (α = 0.68), and confidence (α = 0.59).

Table 2

NCS Items, Scoring, Factor Loadings (Standard Errors) and Item-Total Correlation.

Need for Cognition Item	Factor Loadings (*SE*)	Item-total correlation
1. I would prefer complex to simple problems.	.413 (.07)	.383
2. I like to have the responsibility of handling a situation that requires a lot of thinking.	.570 (.05)	.543
3. Thinking is not my idea of fun. (R)	.598 (.05)	.572
4. I would rather do something that requires little thought than something that is sure to challenge my thinking abilities. (R)	.597 (.05)	.560
5. I try to anticipate and avoid situations where there is likely a chance I will have to think in depth about something. (R)	.650 (.04)	.617
6. I find satisfaction in deliberating hard and for long hours.	.549 (.06)	.534
7. I only think as hard as I have to. (R)	.503 (.06)	.479
8. I prefer to think about small, daily projects to long-term ones. (R)	.456 (.07)	.430
9. I like tasks that require little thought once I've learned them. (R)	.582 (.05)	.572
10. The idea of relying on thought to make my way to the top appeals to me.	.542 (.06)	.499
11. I really enjoy a task that involves coming up with new solutions to problems.	.640 (.05)	.592
12. Learning new ways to think doesn't excite me very much. (R)	.488 (.06)	.458
13. I prefer my life to be filled with puzzles that I must solve.	.622 (.05)	.583
14. The notion of thinking abstractly is appealing to me.	.642 (.05)	.595
15. I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought.	.541 (.06)	.501
16. I feel relief rather than satisfaction after completing a task that required a lot of mental effort. (R)	.488 (.06)	.467
17. It's enough for me that something gets the job done; I don't care how or why it works. (R)	.569 (.05)	.544
18. I usually end up deliberating about issues even when they do not affect me personally.	.287 (.09)	.277

Note. R = reverse coded

Discussion

The data support the NCS as being unidimensional, but with method effects influencing responses to negative items. The original unidimensional model (Cacioppo et al. 1984) that does not take account of the method effects was not a good fit. Tanaka et al.'s (1998) three dimensional model received little support. Although Forsterlee and Ho's (1999) two dimensional response format (positive polarity and negative polarity) model had acceptable fit indices, the undimensional model with correlated errors had the best fit. A trait-method solution was superior to a one-factor solution: in addition to the need for cognition trait factor the findings indicate the presence of method factors, differentiated by the polarity of the items that load on them. Of note, Bors et al. (2006) reported a similar structure and of note, they examined the empirical correlates of the factors determined by the positive and negative items. They found that only the negative polarity factor was associated with verbal ability; need for cognition may correlate with verbal ability not just because of the effects of the need for cognition motivation (as it is typically interpreted as reflecting), but also because the negative polarity items require and measure verbal ability. Clearly such an interpretation requires additional examination as it may raise questions about other established relationships between need for cognition and other constructs. If the negative polarity factor reflects verbal ability, then it is possible that it is this factor and not only cognitive motivation accounts for many of the established relationships between the NCS and other factors. For example, verbal ability may explain the relationships between the NCS and text comprehension performance (e.g., Dai & Wang, 2006). Furthermore, in addition to assessing a motivation to engage in and enjoy effortful cognitive endeavours, the NCS may reflect other individual differences relating to intellectual abilities. Separating the two factors allows investigation of whether patterns of relationships with the overall NCS score are influenced by one of the polarity factors rather than the entire scale. It is possible that some commonly reported relationships between the NCS and psychological constructs reflect a common factor rather than substantively meaningful relationships; further examination of the correlates of the polarity factors is warranted. Of note, studies highlighting psychometric issues arising from scales that comprise a mixture of both positive and negative items (Benson & Hocevar, 1985; Bors et al. 2006; Pilotte & Gable, 1990; Schriesheim & Hill, 1981) have noted that item polarity has an effect on the nature of the construct being measured. However, the nature and consequences of this effect remain to be fully explored within the psychological literature.

The 18-item NCS scale items reflect one substantively meaningful construct and a method effects due to the negatively phrased items; although a single score can justifiably be derived from the NCS, the accuracy of the measurement is predicated on low measurement error and the absence of substantial response bias. The presence of correlated errors makes it difficult to separate measurement error from the construct of interest and as noted by Lucke (2005), there has been little systematic investigation of correlated error terms in psychological measurement. The extent to which internal consistency estimates of reliability are inflated by the presence of such correlated errors is unknown (Rozeboom, 1989). A number of methodological and statistical approaches for the management of method variance attributable to negatively- and positively-valenced items have been proposed.

Methodological suggestions to overcome method variance include the use of heterogenous item formats, inclusion of random dummy items, and breaking up the flow of items by having respondents skip back and forth through the questionnaire, or

having respondents pause at certain points in the questionnaire (Tepper & Tepper, 1993). From a Multitrait-Multimethod Matrix (MTMM) perspective, examining NCS scale scores with alternative methods of assessing the construct could strengthen the conclusions drawn in relation to need for cognition. Statistical approaches include the attempt to control for method variance through explicit modelling of the method effect in a Confirmatory Factor Analysis marker approach (Williams, Edwards, & Vandenberg, 2003). Podsakoff et al. (2003) recommended using an unmeasured latent method construct (ULMC, Williams, Cote, & Buckley, 1989) in CFA of scales. Outside of a structural equation modelling (SEM) framework, Lindell and Whitney (2001) proposed a method for controlling for method effects by partialling out shared variance in bivariate correlations associated with a method covariate. Richardson, Simmering and Sturman (2009) compared the effectiveness of these post hoc techniques to produce corrected estimates of relationships between variables and concluded that none of the methods are to be recommended. Le, Schmidt and Putka's (2009) recently proposed the generalised coefficient of equivalence and stability (GCES) as a means to correct for biasing effects due to measurement artefacts. Such a correction performed as well as SEM procedures in a simulation study (Le et al., 2009). However, additional research is required on the relative merits of the post hoc techniques to control for measurement error.

The present results suggest that separation of the NCS into two empirically identified factors may reflect method effects associated with the use of item wording. In accordance with the method effects explanation, lack of fit of a unidimensional model is a common finding for questionnaires with positively and negatively phrased items. Similar findings have emerged from CFA investigations of other scales comprising a mixture of positive and negative items. For example, Marsh's (1996) investigated whether Rosenberg's (1965) Self Esteem Scale should be considered unidimensional with method effects or whether it assessed two distinct dimensions of self-esteem. Marsh concluded that a unidimensional model with correlated error terms to reflect method effects provide a better fit. A similar conclusion regarding correlated errors among items was made following confirmatory factor analyses of the Life Orientation Test (Scheier, Carver & Bridges, 1994). Thus a number of scales with possible sub-factors comprising item phrasing effects can be best represented in terms of a single substantive psychological construct and method effects.

The reason for the emergence of reverse coding factors in factor analyses of psychological scales has received much attention. Some authors have attributed such effects to respondent characteristics, such as careless responding (Schmitt & Stults, 1985) or lack of cognitive ability (Cordery & Sevastos, 1993), whereas others have suggested that negatively phrased items measure a different construct to the positively phrased items (e.g., Pilotte & Gable, 1990). Although this debate continues, the potential consequences of method effects have been described in terms of reduced validity and reliability (e.g., Pilotte & Gable, 1990). Some have questioned whether the continued use of negatively phrased items in scales is justified (e.g., Duke, Krishnan, Faith, & Storch, 2006; Magazine et al., 1996), although Marsh (1996) recommended that if positively and negatively phrased items are to be included then the proportion should be balanced. The present study, in line, with other previous research highlights the value of conducting CFA on scales comprising both positive and negatively phrased items. The study is limited by the relatively heterogenous nature of the participants in terms of age and education levels. Additional analyses with a wider range of age groups and education levels would be of value.

In conclusion, the unidimensional NCS model with method effects was more parsimonious than positing two or three discrete factors. Rather than adding to the store of constructs in psychology, research needs to examine whether the data upon which such multi-factorial claims are based are better understood in terms of a trait-method effects model (Podsakoff et al., 2003). The findings regarding the dimensionality of the NCS are important since problems with negatively worded items are common in widely used questionnaires. CFA methodology can evaluate the relative contribution of substantively meaningful constructs and method effects, and consequently contributes to the construct validation of NCS.
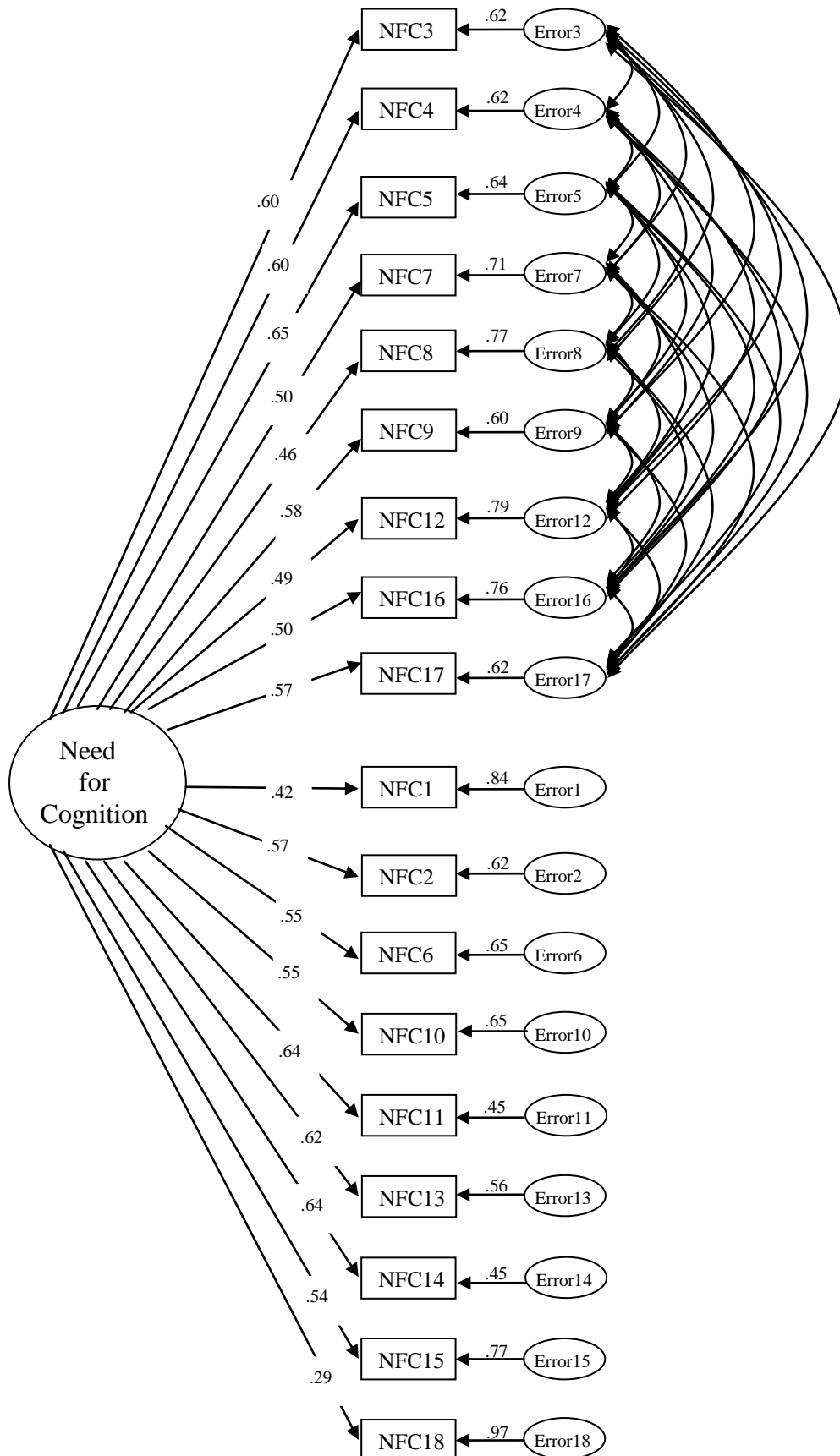
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Figure 1. Confirmatory Factor Model of NFC unidimensional model with correlated errors among negative polarity items

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