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HIGHER ORDER FACTOR STRUCTURE OF A SELF-CONTROL TEST: EVIDENCE FROM CONFIRMATORY FACTOR ANALYSIS WITH POLYCHORIC CORRELATIONS

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The self-control test developed by Grasmick, Tittle, Bursik, and Arneklev was designed to measure each of six components of self-control, namely, impulsivity, a preference for simple rather than complex tasks, risk seeking, a preference for physical rather than cerebral activities, a self-centered orientation, and a volatile temper. This conceptualization clearly suggests that self-control may be defined as a higher order construct that leads to each of these components, which in turn may be represented as first-order factors or constructs. However, due to various limitations, previous analyses of the test failed to establish this factor structure. By employing proper methods for the factor analysis of Likert-type items and explicitly testing a higher order structure, the authors show that the self-control test may provide more valid measurement of the psychological constructs it was intended to measure than previous research suggests.

Keywords: *self-control; factor analysis; higher order models; weighted least squares*

Substantial evidence in the empirical literature shows that self-control is an important personality variable for the prediction of criminality, psychological distress, and interpersonal problems. For example, Gottfredson and

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Hirschi (1990) contend that criminal acts are perpetrated almost exclusively by low self-control individuals. An array of studies by Mischel demonstrates that individual differences in the ability to delay gratification (i.e., exert self-control) in childhood are cross culturally related to an organized pattern of cognitive and personality characteristics associated with more successful functioning (see Mischel, 1974, for an early review). Caspi (2000) has demonstrated that, compared to base-rate estimates, "undercontrolled" 3-year-olds tend to exhibit relatively high rates of behavioral problems, less constraint, more troubled social relations, and greater likelihood of criminality over the following 18 years. In their chapter integrating research pertaining to aggression and the self, Baumeister and Boden (1998) argued that "self-control failure is a pervasive and underappreciated cause of violence" and that "most aggressive impulses or potential responses are prevented by internal restraints" (p. 125). Finkel and Campbell (2001) provided evidence that high self-control individuals in romantic relationships are more likely to respond constructively to a potentially destructive partner than are low self-control individuals. In short, extant literature suggests that possessing high self-control is associated with a variety of positive personal, interpersonal, and societal outcomes.

Grasmick, Tittle, Bursik, and Arneklev (1993) developed and evaluated a measure of self-control that is based on the conceptualization of the construct by Gottfredson and Hirschi (1990). This test consists of 24 items that elicit Likert-type responses from four ordered categories. In describing their development of this test, Grasmick et al. stated that Gottfredson and Hirschi's theory implies that self-control is a unidimensional trait consisting of six components. These components include impulsivity, a preference for simple rather than complex tasks, risk seeking, a preference for physical rather than cerebral activities, a self-centered orientation, and a volatile temper. Grasmick et al. then constructed their self-control test by writing (or adapting from previously published tests) four items to tap each of these six components. Because sets of items were devised to measure six conceptually distinct characteristics on which individuals differ, at one level of abstraction, the Grasmick et al. self-control test is designed to have *six* dimensions (to the extent that the term *dimension* is synonymous with such terms as *factor*, *component*, and *latent construct*) and is *not* unidimensional. At another level of abstraction, however, to the extent that the six components are highly correlated with each other, the six components can be construed as indicators of a unidimensional construct, self-control. This description implies that the self-control test has a higher order factor structure, although Grasmick et al. did not explicitly consider this conceptualization of their measure.

In this article, we present evidence that the measurement validity of the self-control test developed by Grasmick et al. is best understood in terms of this higher order factor structure. Thus, there are three measurement models that we are interested in testing a priori: The first of these is a truly unidimensional model in which each test item is an indicator of a single latent construct, self-control; the second is a full first-order model in which the six distinct "components" of self-control (i.e., separate but correlated latent constructs) are each measured by four test items; and the third model has the higher order factor structure conceptually implied by the combination of the first two models. These models are depicted in Figures 1, 2, and 3, respectively. The full first-order model (i.e., the six-factor structure) has 15 interfactor correlations; in the higher order model, these 15 correlations are essentially reduced to 6 regression coefficients relating the first-order components to the higher order construct, self-control. Thus, in addition to more closely reflecting the psychological theory underlying the construction of the test, the higher order structure offers a more parsimonious representation of the factor structure for the self-control test.

To help assess the dimensionality of their self-control test, Grasmick et al. (1993) performed principal components analysis with the individual item responses as variables. Because a finite set of test items cannot provide perfect measurement of a latent psychological construct such as self-control, many methodologists have bemoaned the use of principal components analysis, which assumes that observed variables have zero measurement error for the purpose of inferring latent constructs (see, e.g., Gorsuch, 1997; Nunnally & Bernstein, 1994). Rather, these authors recommend common factor analytic techniques, which explicitly estimate measurement errors among the observed indicators of latent constructs. Although their use of principal components analysis is debatable, there is some evidence that a higher order factor structure exists within the data of Grasmick et al (1993). Although they ultimately decide to interpret their self-control test in terms of a unidimensional model, Grasmick et al. first examined a six-factor model and then a five-factor model of the test. In general, they found that the factors tended to be defined in terms of the six predefined components, with the exception that one factor tended to combine the impulsivity and simple-task items, such that their five-factor model is mostly identical to the six-factor model but without the Impulsivity factor. Nonetheless, the exploratory principal components analysis conducted by Grasmick et al. suggests that the self-control test may be interpreted either as a multidimensional test or a unidimensional test.

Longshore, Turner, and Stein (1996) employed both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to assess the dimensionality of the self-control test by Grasmick et al. (1993). Their exploratory results were similar to those reported by Grasmick et al. in that they reported that the self-control test tends to have five factors interpretable in terms of the original six components specified by Grasmick et al., with the exception of the Impulsivity factor. When Longshore et al. proceeded to CFA, they tested both the five-factor measurement model implied by their exploratory results as well as a unidimensional measurement model. These authors did not

(text continues on p. 118)

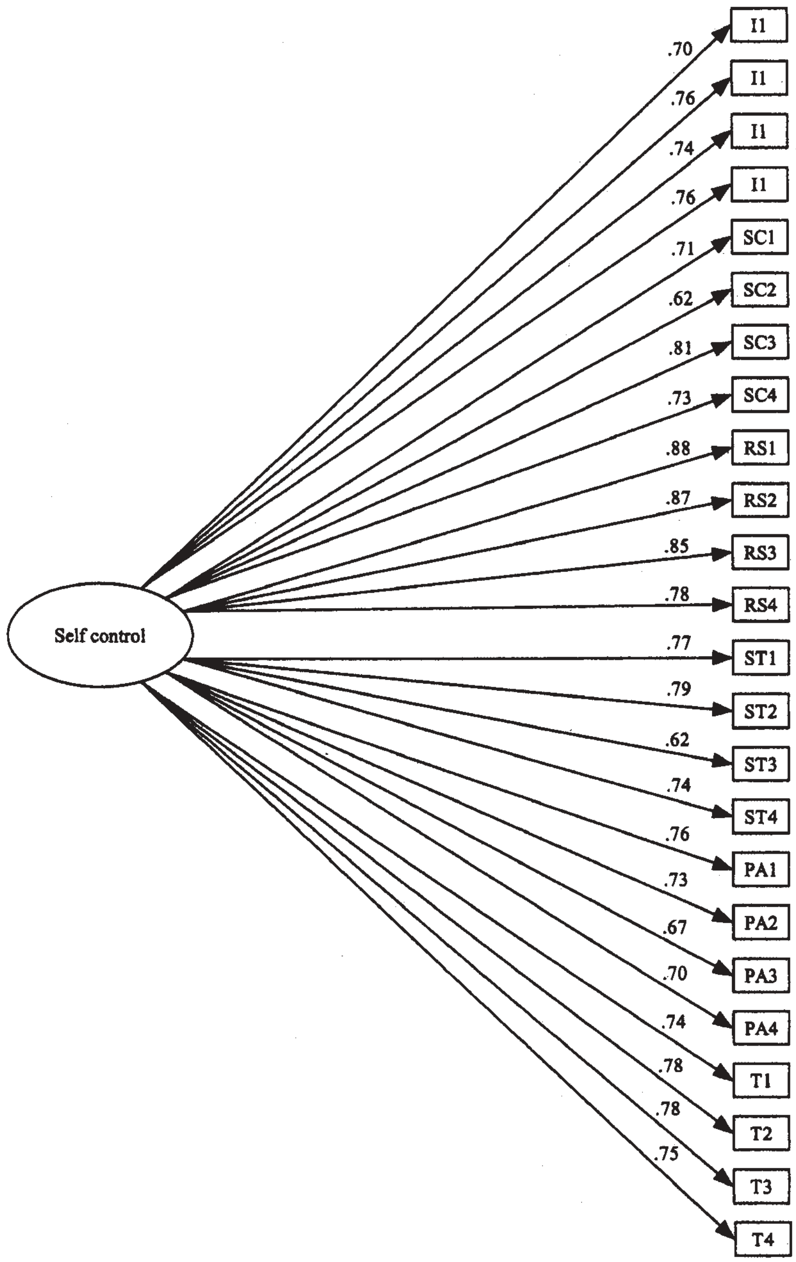

Figure 1. Unidimensional model: Standardized solution.

Note. All paths are significant ($p < .05$). Values associated with each path are standardized regression coefficients.

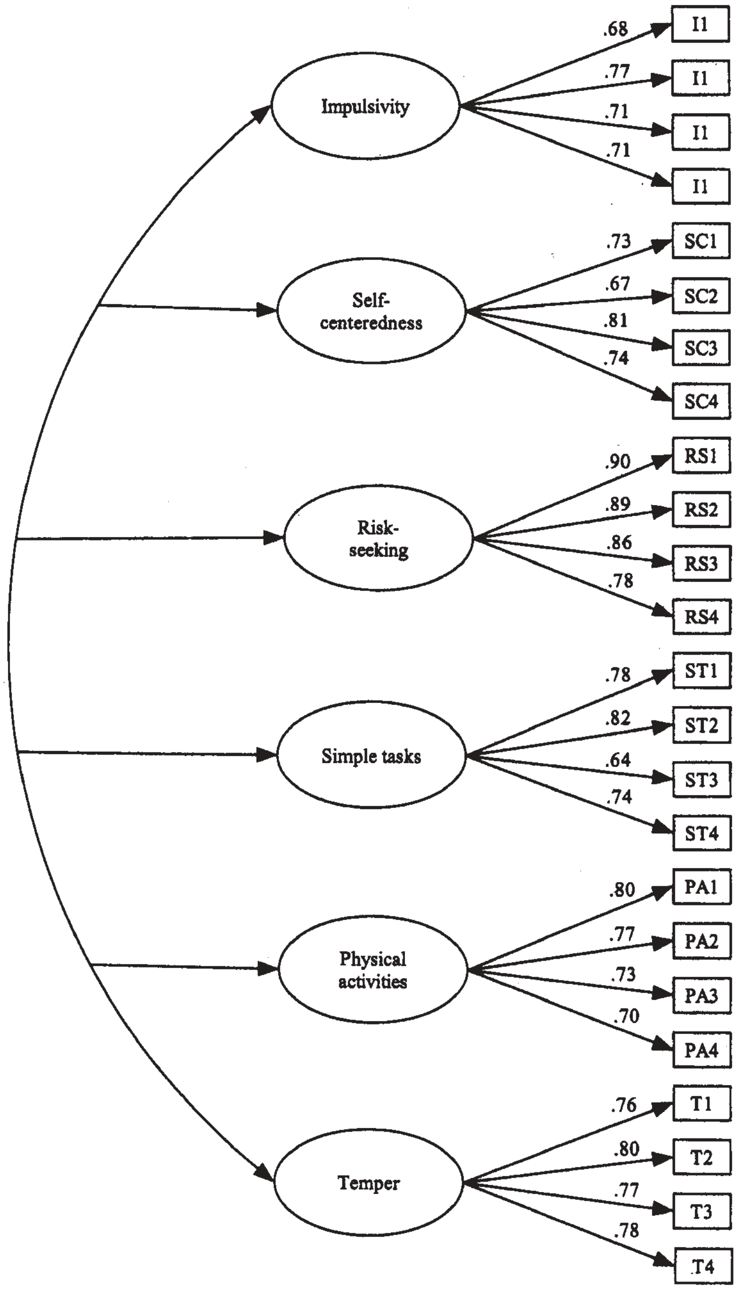

Figure 2. Six-factor model: Standardized solution.
Note. All paths are significant ($p < .05$). Values associated with each path are standardized regression coefficients. For visual clarity, estimates of interfactor correlations are not included in this figure but are presented in Table 2.

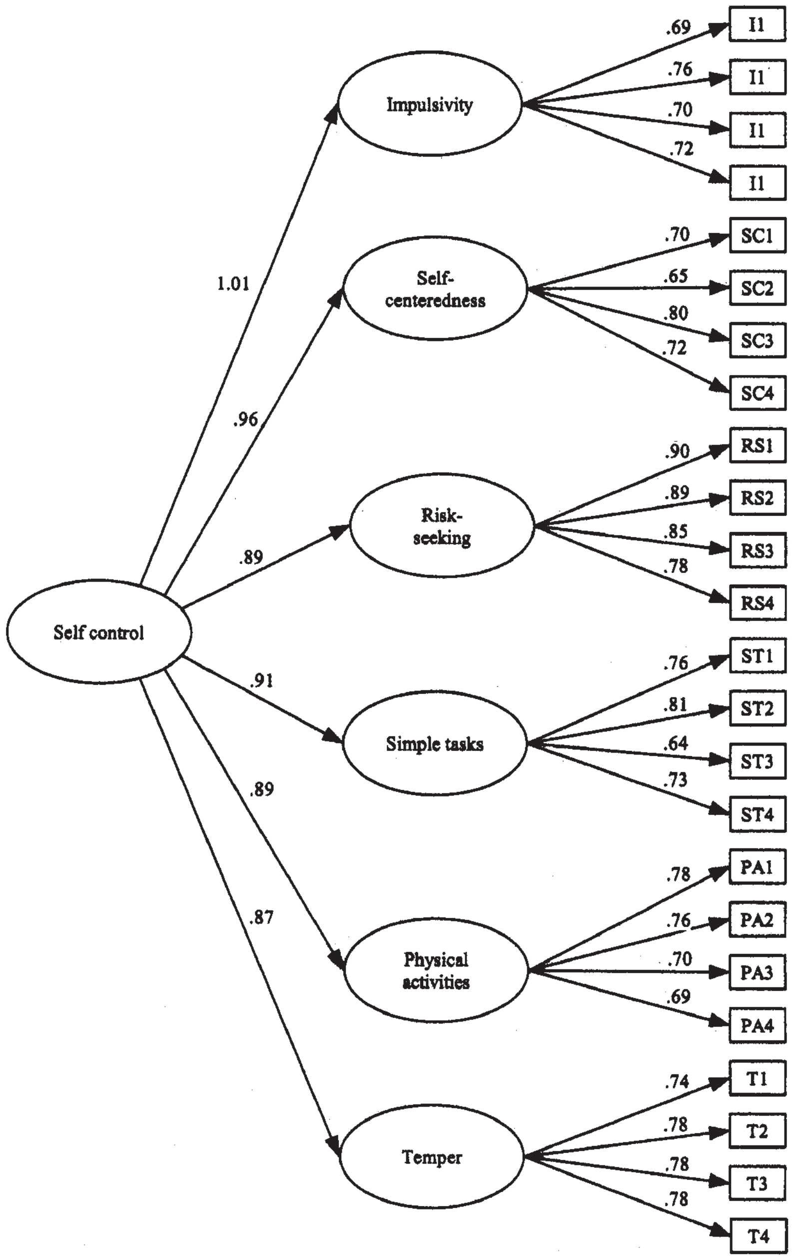

Figure 3. Six-factor higher order model: Standardized solution.
Note. All paths are significant ($p < .05$). Values associated with each path are standardized regression coefficients.

assess a higher order factor structure. Longshore et al. determined that the unidimensional model did not fit their data, and instead they concluded that the five-factor model suggested by their EFA provided the best interpretation of the Grasmick et al. self-control test. Therefore, there is some agreement among Grasmick et al. and Longshore et al. about the distinct characteristics that comprise general self-control; however, whether the Grasmick et al. self-control test is truly unidimensional, measuring a single self-control construct, is not clear.

Ultimately, the Grasmick et al. (1993) and Longshore et al. (1996) studies both suffer from the same shortcoming, which is that they fail to consider the distributional properties of their observed item responses. When item responses are given using a Likert-type scale format, the observed responses are ordered, categorical manifestations of a continuous, psychological process of judgment about item content. Research with both empirical data sets and simulated data has demonstrated extensively that factor analytic techniques, whether exploratory or confirmatory, that rely on normal-theory estimation using Pearson product-moment relations are not robust to such categorization of continuous variables (see, e.g., Bollen, 1989; Nunnally & Bernstein, 1994; West, Finch, & Curran, 1995). Estimation problems occur because categorization of continuous variables attenuates the correlations among them. Likely consequences include biased model fit statistics (such that power to reject a model is too high), negatively biased parameter estimates, inflated error variances, and extraction of spurious factors. Therefore, the use of factor analysis to assess the dimensionality of a set of test items requires consideration of the measurement scales of the observed item responses.

An alternative to the Pearson product-moment correlation coefficient is the polychoric correlation. A polychoric correlation measures the linear relationship between two observed, discrete variables that are manifestations of latent, normal continuous variables. Thus, a polychoric correlation is a more appropriate measure of the relationship between two Likert-type items on a test than the Pearson correlation (Olsson, 1979). It follows that the matrix of polychoric correlations is more appropriate than the matrix of Pearson correlations for analysis with either EFA or CFA when ordinal test items serve as observed variables.

Because a set of Likert-type items does not have a multivariate-normal distribution, the normal-theory maximum likelihood method of factor estimation that is typically employed in CFA is not the best method of estimation for assessing the factor structure of such variable, even when applied to a matrix of polychoric correlations (see, e.g., Bollen, 1989, p. 443). Instead, it is best to apply weighted least squares (WLS) estimation to the matrix of polychoric correlations, where the weight matrix is defined as a consistent estimator of the asymptotic covariance matrix among all polychoric correlations between items. Muthén (1984, 1993) described this approach in detail, and it is becoming more widely available in software packages.

In the analyses that follow, by using appropriate methods for CFA of Likert-type variables, we show that the Grasmick et al. (1993) self-control test is best represented with a higher order factor structure. As described above, these methods involve the analysis of the matrix of polychoric correlations among all test items using WLS estimation. By testing a higher order factor structure, we illustrate how this self-control test provides a more valid measurement of the self-control construct defined by Gottfredson and Hirschi (1990) than previous factor-analytic results suggest.

Method

Participants and Procedure

The self-control test data used for the present analyses were collected in the fourth wave of a six-wave evaluation study of an adolescent dating abuse prevention program, the details of which are delineated elsewhere (Foshee et al., 1996, 1998, 2000). The study was conducted in 14 middle and high schools in a predominantly rural county in North Carolina. Schools were stratified by grade (8th or 9th grade) and matched on school size. One school from each of seven matched pairs was randomly assigned to receive the dating abuse prevention program. Participants were eligible for the evaluation study if they were enrolled in the 8th or 9th grade in the county school system on September 10, 1994. Eighty-one percent (n = 1,966) of the 8th or 9th graders in the county completed baseline questionnaires. Fifty-five percent (n = 1,085) of these participants completed the wave four questionnaires, which included the self-control test. The participants were in the 10th and 11th grades when they completed the self-control test.

Participants were presented with all 24 items from the original Grasmick et al. (1993) self-control test. Each item was rated on a 4-point Likert-type scale from *strongly agree* (0) to *strongly disagree* (3).

Data Subsampling

Before conducting the statistical analyses, we divided the full sample with 1,085 observations into two subsamples, one for the exploratory phase of the analyses and one for the confirmatory phase. The exploratory sample consisted of approximately one third of the full sample and was extracted using random selection without replacement. The remaining observations were used for the confirmatory analyses. After we divided the data into the two subsamples, we deleted all cases that did not have responses for all 24 items on the self-control test (5.44% of cases). After deleting these cases with missing values, the exploratory subsample had 359 cases, whereas the confirmatory subsample had 667 cases.

Results

Exploratory Analyses

In this phase of the analysis, we used the sample of 359 cases to conduct EFA, with all 24 self-control test items as variables. The analysis proceeded by first calculating the matrix of polychoric correlations among all possible pairs of items. Next, we conducted EFA with the polychoric correlations using a version of WLS estimation, namely, the "WLSMV" estimator available with MPlus (Muthén & Muthén, 1998). Here, we briefly summarize the results of our EFA analyses.

To assess the number of factors underlying the set of test items, we examined a scree plot of the eigenvalues resulting from this analysis. The plot clearly showed that a one-factor solution might be adequate to explain the relationships among these items. However, the plot also suggested that a six-factor solution might underlie the data. Ultimately, we chose to examine the one-factor (or unidimensional) solution and the six-factor solution. Because we expected the factors to be highly correlated, we applied an oblique rotation, the Promax method, to the six-factor solution to aid interpretation. The complete six-factor solution is presented in Table 1.

In sum, the EFA results are quite similar to those reported by Grasmick et al. (1993) in the sense that there seem to be strong factors for each predefined component of self-control, with the exception of the impulsivity component. However, in contrast to the conclusions reached by Grasmick et al., the one-factor solution accounted for the data poorly (the factor accounts for only 40.5% of total variance), suggesting that a unidimensional model does not sufficiently explain the relationships among the items. It is noteworthy that, for the six-factor solution, the correlations among the rotated factors were all rather large. These uniformly high interfactor correlations indicate that a higher order factor structure might provide the optimal model for these items.

Confirmatory Analyses

In this phase of the analysis, we fitted several models using CFA (see, e.g., Bollen, 1989) to the data from the subsample of 667 participants. Again, the observed variables for these analyses were the set of 24 items from the self-control test. As in the exploratory phase, we began by calculating the matrix of polychoric correlations among all 24 items. We used PRELIS Version 2.2 (Jöreskog & Sörbom, 1998b) to calculate these correlations. The weight

Table 1
Exploratory Factor Analysis: Six-Factor Solution

	Factor					
	1	2	3	4	5	6
Proportion of variance explained	13.40	6.42	12.89	5.73	11.11	11.34
Promax-Rotated Factor Pattern						
Item						
T1	**.80**	.07	–.06	.08	–.10	–.13
T2	**.79**	.08	–.04	–.03	–.04	.15
T3	**.83**	–.11	–.03	–.06	.01	.21
T4	**.75**	–.02	–.05	.10	.06	–.11
SC1	.10	**.37**	.28	–.16	.19	.08
SC2	–.03	**.59**	.02	.10	.17	–.06
SC3	–.01	**.66**	.10	.08	.15	.03
SC4	–.13	.20	–.01	–.02	.22	**.40**
RS1	–.09	.09	**.91**	.10	–.01	–.08
RS2	–.08	.02	**.90**	.14	–.03	.01
RS3	.22	–.01	**.55**	–.07	–.02	.37
RS4	.04	.08	**.39**	.29	–.15	.30
ST1	–.07	.14	.00	–.07	**.76**	.07
ST2	.00	–.06	–.02	.07	**.81**	.03
ST3	.09	.17	–.13	.03	**.47**	.16
ST4	.10	.21	–.21	**.37**	.23	.14
PA1	.01	–.35	.19	**.58**	.20	.20
PA2	.12	.00	.16	**.65**	.07	–.18
PA3	–.02	.18	–.02	**.73**	.04	–.11
PA4	–.07	.16	–.01	**.68**	–.20	.14
I1	**.36**	.12	.34	–.09	.21	–.18
I2	.16	.01	.20	**.27**	.11	.25
I3	.22	**.48**	–.03	.04	–.11	.26
I4	.00	.02	–.04	.02	.19	**.70**
Interfactor correlations						
Factor						
2	.53					
3	.49	.41				
4	.45	.43	.48			
5	.46	.53	.34	.40		
6	.37	.49	.43	.47	.46	

Note. N = 359. Entries in bold are the highest coefficient per item. T = Temper; SC = Self-Centeredness; RS = Risk Seeking; ST = Simple Tasks; PA = Physical Activities; I = Impulsivity. Total proportion of variance explained = 60.89.

matrix to be used for the WLS estimation, the asymptotic covariance matrix, was also generated using PRELIS. Once PRELIS generated these matrices, we used WLS estimation implemented by LISREL Version 8.2 (Jöreskog & Sörbom, 1998a) to estimate the models of interest described in the introduction as well as a model implied by our exploratory analyses. Typically, the χ^2

statistic is used to test the fit of CFA models. However, with sample sizes as large as those used here, this test has excessive Type I error rates (see, e.g., Bollen, 1989, p. 268). Thus, we assess model fit using several statistics in addition to the traditional χ^2 test. These include root mean squared error of approximation (RMSEA) (Steiger, 1990), for which smaller values (e.g., less than .05) are indicative of good fit, and the confirmatory fit index (CFI) (Bentler, 1990), for which we consider values greater than .95 indicative of good fit. Conventionally, RMSEA values greater than .05 have been considered suggestive of poor fit. However, recent research has suggested that this cutoff value may be overly stringent (Curran, Bollen, Paxton, Kirby, & Chen, 2000).

Unidimensional model. First, we tested a unidimensional (i.e., one-factor) model. This model provided marginal fit to the data, with $\chi^2(252) = 953.36$, $p < .001$; RMSEA = .065 with 95% confidence interval (CI) from .059 to .070; and CFI = .96. The standardized parameter estimates for this model are given in Figure 1. Cronbach's coefficient alpha (α) for the set of 24 items was .91 with 95% CI (.898, .918), further indicating that the unidimensional self-control construct has adequate internal consistency. Surprisingly, Grasmick et al. (1993) found α equal to only .81 with the same items but different respondents. In general, however, we feel that the marginal fit of the model suggests that a strict unidimensional interpretation of the self-control test oversimplifies its true measurement model.

When we fit this model using normal-theory maximum likelihood with product-moment covariances, the model does not seem to fit the data even marginally, with $\chi^2(252) = 2043.95$, $p < .001$; RMSEA = .103 with 95% CI (.098, .108); and CFI = .70.

First-order six-factor model. Next, we assessed the fit of a model with six correlated factors. This model provided very good fit to the data, with $\chi^2(237) = 663.51$, $p < .001$; RMSEA = .052 with 95% CI (.046, .058); and CFI = .98. The standardized parameter estimates (i.e., factor pattern coefficients) for this model are given in Figure 2, whereas Table 2 gives the pattern coefficients, structure coefficients, and interfactor correlations. It appears that this multidimensional model gives a better description of the relationships among the 24 self-control items than does the unidimensional model. Of particular interest are the parameter estimates relevant to the Impulsivity factor. Each of the impulsivity items has significant, positive coefficients on the Impulsivity factor. Thus, in spite of previous exploratory analyses, this result suggests that the four impulsivity items may in fact be conceptualized as indicators of a single, latent impulsivity factor. As was the case in the exploratory analysis, all six factors are highly correlated, implying the presence of a higher order factor. Furthermore, the structure coefficients show that most items are highly correlated with each of the six factors.

Table 2
Confirmatory Factor Analysis: Standardized First-Order Six-Factor Solution

	Factor											
	I		SC		RS		ST		PA		T	
Item	Pattern Coefficients (Structure Coefficients)											
I1	**.68**	**(.68)**	.00	(.64)	.00	(.58)	.00	(.61)	.00	(.60)	.00	(.58)
I2	**.77**	**(.77)**	.00	(.73)	.00	(.67)	.00	(.70)	.00	(.69)	.00	(.67)
I3	**.71**	**(.71)**	.00	(.66)	.00	(.61)	.00	(.63)	.00	(.62)	.00	(.60)
I4	**.71**	**(.71)**	.00	(.67)	.00	(.62)	.00	(.64)	.00	(.63)	.00	(.61)
SC1	.00	(.69)	**.73**	**(.73)**	.00	(.61)	.00	(.58)	.00	(.57)	.00	(.61)
SC2	.00	(.62)	**.67**	**(.67)**	.00	(.54)	.00	(.51)	.00	(.50)	.00	(.55)
SC3	.00	(.76)	**.81**	**(.81)**	.00	(.67)	.00	(.63)	.00	(.62)	.00	(.67)
SC4	.00	(.68)	**.74**	**(.74)**	.00	(.60)	.00	(.57)	.00	(.56)	.00	(.61)
RS1	.00	(.78)	.00	(.75)	**.90**	**(.90)**	.00	(.64)	.00	(.73)	.00	(.67)
RS2	.00	(.77)	.00	(.74)	**.89**	**(.89)**	.00	(.64)	.00	(.73)	.00	(.67)
RS3	.00	(.74)	.00	(.72)	**.86**	**(.86)**	.00	(.62)	.00	(.70)	.00	(.64)
RS4	.00	(.66)	.00	(.64)	**.78**	**(.78)**	.00	(.55)	.00	(.62)	.00	(.57)
ST1	.00	(.71)	.00	(.62)	.00	(.56)	**.78**	**(.78)**	.00	(.61)	.00	(.59)
ST2	.00	(.74)	.00	(.64)	.00	(.59)	**.82**	**(.82)**	.00	(.63)	.00	(.62)
ST3	.00	(.57)	.00	(.50)	.00	(.45)	**.64**	**(.64)**	.00	(.49)	.00	(.48)
ST4	.00	(.65)	.00	(.57)	.00	(.52)	**.74**	**(.74)**	.00	(.56)	.00	(.55)
PA1	.00	(.71)	.00	(.61)	.00	(.65)	.00	(.62)	**.80**	**(.80)**	.00	(.55)
PA2	.00	(.68)	.00	(.59)	.00	(.63)	.00	(.59)	**.77**	**(.77)**	.00	(.53)
PA3	.00	(.64)	.00	(.55)	.00	(.59)	.00	(.55)	**.73**	**(.73)**	.00	(.50)
PA4	.00	(.61)	.00	(.54)	.00	(.57)	.00	(.54)	**.70**	**(.70)**	.00	(.48)
T1	.00	(.65)	.00	(.63)	.00	(.56)	.00	(.57)	.00	(.52)	**.76**	**(.76)**
T2	.00	(.70)	.00	(.68)	.00	(.60)	.00	(.61)	.00	(.56)	**.80**	**(.80)**
T3	.00	(.66)	.00	(.64)	.00	(.57)	.00	(.58)	.00	(.53)	**.77**	**(.77)**
T4	.00	(.67)	.00	(.65)	.00	(.58)	.00	(.59)	.00	(.54)	**.78**	**(.78)**

Interfactor Correlations

Factor	I	SC	RS	ST	PA	T
SC	.94					
RS	.86	.83				
ST	.90	.78	.72			
PA	.88	.77	.82	.77		
T	.86	.84	.75	.76	.69	

Note. $N = 667$. Entries in bold are freed parameter estimates (i.e., pattern coefficients *not* constrained to zero). Entries in parentheses are factor structure coefficients (i.e., correlations). I = Impulsivity; SC = Self-Centeredness; RS = Risk Seeking; ST = Simple Tasks; PA = Physical Activities; T = Temper.

When we fit this model to the data using maximum likelihood with product-moment covariances, the model seems to fit the data only marginally, with $\chi^2(237) = 792.34$, $p < .001$; RMSEA = .059 with 95% CI (.054, .065); and CFI = .91.

Higher order six-factor model. Finally, we assessed the fit of a six-factor higher order model. This model also provided very good fit to the data, with $\chi^2(246) = 706.36$, $p < .001$; RMSEA = .053 with 95% CI (.048, .058); and CFI = .97. The standardized parameter estimates for this model are given in Figure 3. Again, each of the impulsivity items has significant, positive coefficients on the predefined Impulsivity factor, suggesting that the self-control test may indeed provide a valid measurement of the impulsivity component.

Because this higher order model explains the data more parsimoniously than the first-order six-factor model, its goodness of fit cannot be better than that of the first-order model. To assess the fit of our higher order model relative to a full first-order model, we calculated the "target coefficient" described by Marsh and Hocevar (1985), which is the ratio of the full first-order χ^2 value to that of the higher order model. In the present case, this ratio is 0.94, indicating that the higher order self-control factor accounts for a very large portion of the covariation among the first-order factors.

As with the other models, analyses based on maximum likelihood with product-moment covariances suggested worse model fit, with $\chi^2(246) = 868.28$, $p < .001$; RMSEA = .062 with 95% CI (.056, .067); and CFI = .89.

Discussion

In the above analyses, we have assessed the dimensionality of the self-control test of Grasmick et al. (1993) using appropriate methods for the factor analysis of Likert-type data. Specifically, these methods involve the analysis of polychoric correlations using WLS factor estimation. In this way, we find that each of the models we considered seems to fit the data adequately, with the possible exception of the unidimensional model. Although the models all fit the data very well with respect to the CFI statistic, the model with the best fit statistics is the six-factor model. However, it is important to recognize that the six factors in this model are all highly correlated with each other, which implies the presence of a higher order factor. Furthermore, the general theory of crime by Gottfredson and Hirschi (1990) is the psychological theory that guided the construction of the self-control test by Grasmick et al. This theory clearly implies that a higher order factor, self-control, underlies the relationships among the six components of self-control nominally assessed by the test. Hence, because the models we tested seem to fit the data approximately equally, we contend that theory and parsimony should determine which is the best measurement model for the self-control test. For this reason, the best measurement model is clearly the higher order six-factor model. The Marsh and Hocevar (1985) target coefficient further supports this claim.

Other analyses suggest that when the data are analyzed using more traditional methods (i.e., normal-theory maximum likelihood analysis of Pearson product-moment relations), the fit statistics for each model are much worse, which could potentially lead to incorrect conclusions about the true factor structure of the self-control test.

Our conclusions are in strong contrast to the previous interpretations of the self-control test from Grasmick et al. (1993), who ultimately concluded that their test measures a unidimensional construct, and Longshore et al. (1996), who suggested that this self-control test measures five distinguishable but correlated constructs. Certainly, sampling variance and differences in data collection methods provide partial explanation for the differences across studies. However, the statistical methods used to determine the dimensionality, or factor structure, underlying the self-control test also varied across studies. We feel that the statistical theory guiding the techniques discussed and applied here is particularly well suited to the assessment of dimensionality among Likert-type test items.

Perhaps the most striking difference between the results of previous studies and our own is with respect to the set of items tapping the impulsivity component of self-control. Both Grasmick et al. (1993) and Longshore et al. (1996) concluded that the four impulsivity items do not form a reliable factor within the self-control test. However, using our confirmatory subsample data, we found that coefficient alpha for the four impulsivity items alone is equal to .65 with 95% confidence interval (.607, .693), which reflects good internal consistency for a set of only four items.

The statistical techniques applied by Grasmick et al. (1993) and Longshore et al. (1996) are similar to our own in some respects but ultimately lack two considerations that we feel are vital to understanding the dimensionality and hence the validity of the self-control test developed by Grasmick et al. for measuring the self-control construct defined by Gottfredson and Hirschi (1990). The first of these considerations is the notion that Likert-type test items have ordered, categorical observed distributions, and therefore traditional normal-theory estimation procedures, such as those used in previous analyses, are limited for such data. Hence, the approach we employ is to analyze polychoric correlations with WLS estimation, which explicitly accounts for the fact that test items elicit discrete distributions that nonetheless provide estimations of continuous psychological constructs. Neither Grasmick et al. nor Longshore et al. accounted for the discrete nature of their observed item-level data by analyzing polychoric correlations. This is a common limitation in research that attempts to analyze the dimensionality of tests including Likert-type items.

The second consideration not accounted for in previous analyses of the self-control test is the notion that a higher order factor structure is an appropriate measurement model when psychological theory suggests that a general construct, here self-control, is defined by a more specific set of correlated constructs, here the six components of self-control defined by Gottfredson and Hirschi (1990) and implemented by Grasmick et al. (1993) for their self-control test. To the extent that the higher order factor model we advocate herein posits the self-control test as a measure of a unidimensional construct—namely, self-control—we expected that the unidimensional model should provide marginal to good fit to the data, although a strictly unidimensional model is an oversimplification of the a higher order model. This higher order factor model fits our data quite well and provides the most comprehensive measurement model for the self-control test in terms of the original psychological construct the test was designed to measure.

In conclusion, by carefully considering the statistical properties of our data and by testing the model most strongly implied by theory, we have demonstrated that this self-control test provides a more valid measurement of the self-control construct defined by Gottfredson and Hirschi (1990) than previous factor-analytic results suggest. With this result in hand, future studies should address the predictive validity of this factor model, with particular focus on differential prediction of the separate first-order components relative to the higher order construct, self-control.

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