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Does Strength-Based Parenting Predict Academic Achievement?

The Mediating Effects of Perseverance and Engagement

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Supplementary Material

Validity of Student Grades as a Measure of Academic Achievement

As described in the Methods section of the main paper, an average measure of student grades for Semester 2 Art/Music, Humanities, Science, and Other was utilized in our analysis. Two questions that one may ask about this decision are (a) is creating a composite measure of student grades a valid approach to take, given that students may perform well in one subject and poorly in another? and (b) is school grades a representative measure of achievement more broadly, given that the calculation of grades is specific to the school. To address these potential concerns, convergent and external validity checks were undertaken on our own sample, and are detailed here.

Convergent Validity

Correlations between subject categories. Table S1 describes correlations between categories of school grades. As can be observed, correlations between categories are substantial, varying between r = .38 (science and art/music) and .71 (science and humanities).

Table S1
Zero-order Correlations of Subject Category Variables

Variable	1.	2.	3.
1. Art/Music			
2. Humanities	.41		
3. Science	.38	.71	
4. Other	.44	.56	.55

Note. All correlations presented here are statistically significant, Bonferroni-corrected for multiple comparisons.

Exploratory Factor Analysis of subject category variables. Next, an exploratory factor analysis (EFA) was undertaken to investigate whether the assessment scores across subjects in our sample can be meaningfully represented by an composite, for the purpose of our investigation. Our hypothesis was that there would be a clear single factor that should emerge to support the connection between these different academic modules.

Kaiser's measure of sampling adequacy produced a value of .76, indicating that the data was factorizable (Cerny & Kaiser, 1977). As can be seen in Figure S1, the scree plot, parallel analysis, and Kaiser method all suggested 1 factor, as did the MAP test and Very Simple Structure. Only the parallel analysis indicated that 2 factors fit the data better. Table S2

depicts the factor loadings from a direct oblimin rotated factor analysis using ordinary least squares. Adopting a cut-off value of .50 for a primary loading, we can see in Table S2 that in the 1-factor solution, items all load onto a single factor at greater than .50. This gives us confidence that convergent validity is acceptable for a single average scored school grades variable.

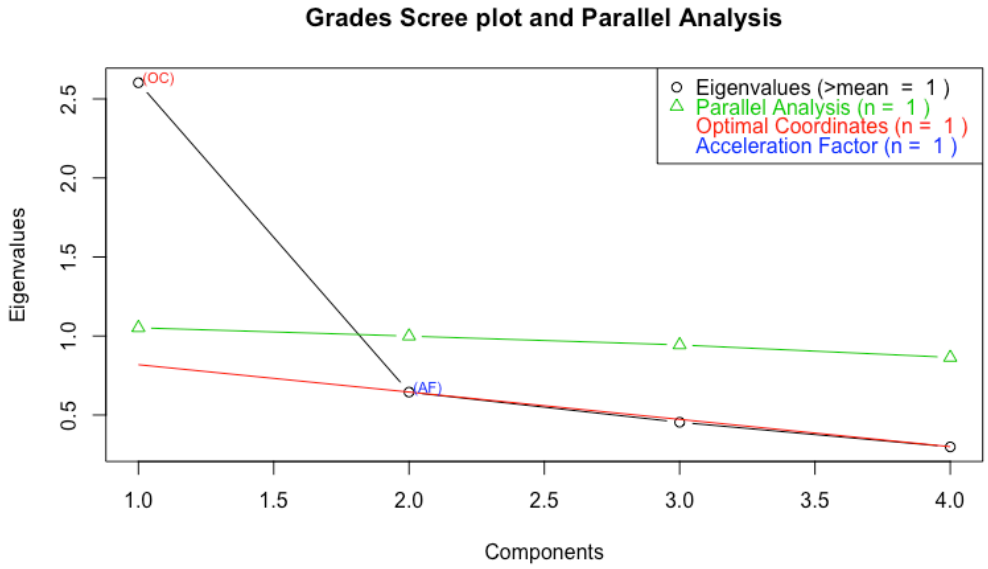

Figure S1. Scree plot, depicting the change in eigenvalues with the addition of more components. Optimal coordinates and acceleration factor are objective measures of interpreting the scree plot.

Table S2.
Factor Loadings for a One-Factor Solution

Subject	Loading
Art/Music	.502
Humanities	.845
Science	.679
Other	.822

External Validity

To investigate the external validity of this measure in our own sample, we considered the results obtained by Semester 1 2016 alongside the results obtained by a nationwide standardized test, the Progressive Achievement Test (PAT). We obtained PAT math and English scores for a subset of participants dating from 2014 to 2016, and assessed the correlations between these measures and the average of student grades. Correlations between average school grades and PAT measures (supplementary material Table S3) were substantial, varying between $r = .53$ and $r = .68$. These results indicate that school grades are effective at representing the results that would be obtained in a standardized measure of achievement in secondary school students.

Table S3.
Correlation Matrix of Progressive Achievement Test (PAT) Scores With Average Results

Variable	1	2	3	4	5	6	7	8	9
1. Average Result									
2. PAT Reading Year 6	.53								
3. PAT Reading Year 7	.62	.67							
4. PAT Reading Year 8	.55	.47	.74						
5. PAT Reading Year 9	.61	NA	.78	.73					
6. PAT Maths Year 6	.53	.60	.64	.49	NA				
7. PAT Maths Year 7	.67	.62	.67	.59	.57	.78			
8. PAT Maths Year 8	.68	.64	.69	.61	.57	.72	.87		
9. PAT Maths Year 9	.64	NA	.73	.63	.62	NA	.86	.87	

Note. Pat = Progressive achievement test.

Results Using Complete Cases

As discussed in the manuscript body, we initially obtained survey data from 741 students in May 2016. This sample was split into an exploratory (*n*=185) and cross-validated confirmatory sample (*n* = 556) to facilitate best practice hypothesis testing (Yarkoni & Westfall, 2017). In July we obtained academic achievement data for 388 of the students who were part of our confirmatory sample. As there was no reason to believe that the data was not Missing Completely At Random, all analyses in the manuscript body were undertaken using pairwise deletion (with the exception of the discriminant validity analysis that utilised the complete sample after removal of two cases with missing data (*n*=739). However, to ensure that our analyses were not subject to biased estimates due to unequal sample sizes, in this section we present the results of the our analyses using only complete cases (i.e. listwise rather than pairwise deletion).

Descriptive statistics and correlations. Table S4 displays the means, standard deviations, and correlation matrix for all variables of interest using complete cases, with the values from the original correlation matrix (Table 1, body) presented in parentheses. As can be observed, means, standard deviations, and correlations are very similar or identical to those originally presented.

Table S4
Zero-order Correlations Using Complete Cases

Variable	*M*	*SD*	1.	2.	3.
1. SBP	5.10(5.17)	1.42(1.38)			
2. Engagement	4.87(4.84)	1.23(1.25)	**.32(.35)**		
3. Perseverance	4.86(4.87)	1.27(1.26)	**.44(.45)**	**.50(.50)**	
4. Achievement	60.98(60.98)	16.82(16.82)	.12(.12)	**.19(.19)**	**.29(.29)**

Note. SBP = strength-based parenting. All correlations presented here are statistically significant. Correlations < .001 (Bonferroni-corrected for multiple comparisons) are highlighted in **bold.** Values in parentheses depict the correlations presented in Table 1 in the body of the paper.

Structural Equation Modeling. According to Hu and Benter's (1999) rules of thumb, model fit of the mediation using complete cases was good for most fit statistics, $\chi^2(223) = 657.03$, $p < .001$, CFI = .95, SRMR = .04 and acceptable for the RMSEA, RMSEA = .07. With the exception of the chi-square value, these statistics are identical to what was previously found using the full original dataset.

Figure S2 presents the standardized β weights for the various pathways in the model. Coefficients predicting academic achievement (SBP, engagement, perseverance) had identical weights in both versions of the mediation. Other values were very similar, at most 4 points different (the pathway from SBP to Engagement, which was 0.38 in the supplementary mediation and 0.42 in the original mediation).

Table S5 presents the mediation model direct, indirect, and total effects, including the original mediation model results in parentheses to observe any differences. Similarly to the model presented in the body of this paper (Table 2), this mediation model revealed a significant indirect effect of SBP on academic achievement, via perseverance; and also similarly to the main model, no significant indirect effect was observed through engagement. There was, again, no direct effect of SBP on academic achievement. Thus, the total effect of academic achievement was indirectly transmitted by the adolescents' level of perseverance. In addition, multi-group comparisons of the factors of interest (SBP, engagement, perseverance) revealed invariance in both the factor loadings and latent mean scores in the sub-sample with academic results (n=388) and the sub-sample without academic results (n=168) (Table S6-7). This result suggests that both interpretation of the scale items and relationships between the latent factors of interest were similar in these two sub-samples, supporting the likelihood that the substantive results will be reproducible in larger, future samples.

Table S5
Standardized Beta Coefficients (β) Of Mediation Analyses Regarding SBP, Engagement, Perseverance, and Academic Achievement

Mediation Model	*β*	*SE*	*Z*	*p*-value
Direct Effect	-0.07(-0.07)	0.07(0.07)	-1.12(-1.10)	.265(.271)
Indirect Effect via E	0.02(0.02)	0.03(0.03)	0.59(0.73)	.554(.468)
Indirect Effect via P	0.17(0.17)	0.05(0.05)	3.54(3.78)	<.001(<.001)
Total Effect	0.11(0.12)	0.06(0.06)	1.93(2.15)	.054(.031)

Note. SBP = strength-based parenting, E = engagement, P = Perseverance, SE = standard error of *β*. Values in parentheses depict the values from the main paper (Table 2) where Full Estimation Maximum Likelihood was used.

Table S6
Nested Models Demonstrating Measurement and Structural Invariance across Groups with and without Academic Results

Model	χ^2 (df)	RMSEA	SRMR	CFI	AIC	$\Delta\chi^2$	ΔCFI
Configurable	1065.48 (408)	.05	.065	.941	1261.481		
Measurement invariance	1073.520 (426)	.05	.067	.942	1233.520	8.038 (18)	.001
Latent mean structure invariance	1095.512 (445)	.05	.066	.941	1305.512	21.992 (22)	-.001

Note: A non-significant (p>.01) χ^2 difference, or change in CFI values less than .01 are both considered to demonstrate measurement invariance (Cheung & Rensvold, 2002). Configurable model was comprised of strength-based parenting (higher order factor), engagement and perseverance, freely covaried (Byrne, 2010, Chapter 8).

Table S7
Difference in Latent Mean Estimates across Groups with and without Academic Results in the Latent Mean Structure Invariance Model

Latent Factor	Latent Mean Difference	Standard Error	Critical Ratio	*p*
Strength-based parenting (higher order)	.231	.130	1.779	.075

Engagement	-.076	.114	-.664	.506
Perseverance	.048	.122	.388	.698

Note. As the sub-sample with academic results was used as a reference group, positive direction of the mean estimate reflects higher scores in the sub-sample without academic results (Byrne, 2010, Chapter 8).

References

Byrne, B. M. (2010). *Structural equation modeling with AMOS : basic concepts, applications, and programming*. New York : Psychology Press, c2010.

Cheung, G. W., & Rensvold, R. B. (2002). Evaluating goodness-of-fit indexes for testing measurement invariance. *Structural equation modeling*, *9*(2), 233-255.

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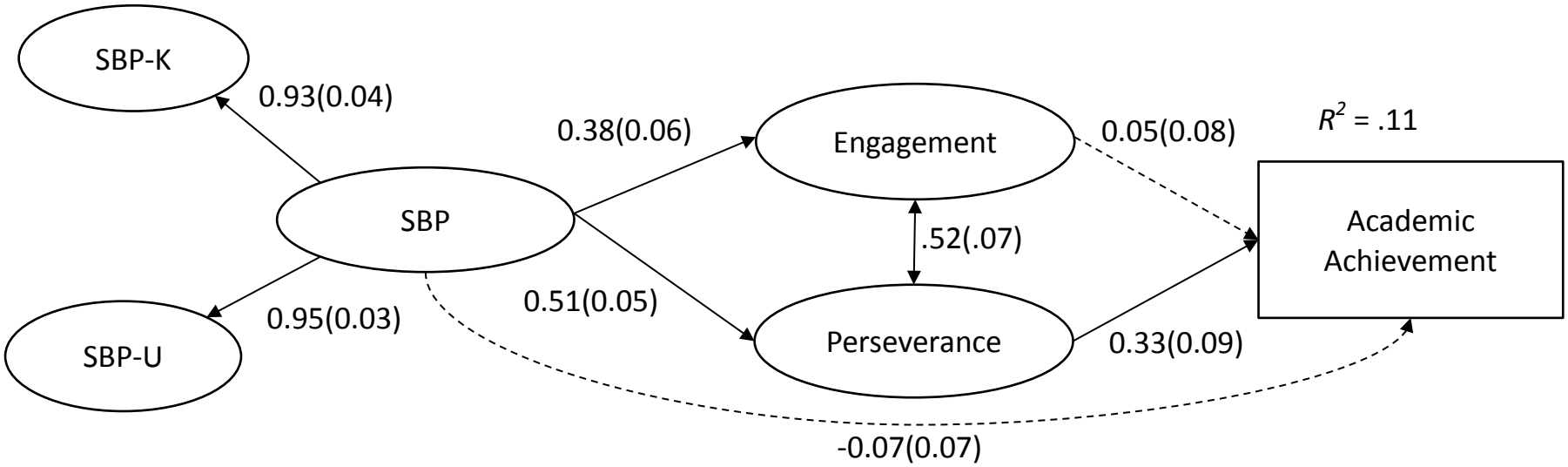

Figure S2. A depiction of standardized β coefficients of direct paths in this model. Values in parentheses refer to the standard error of β. Dotted lines indicate that a pathway is not significant All significant pathways are p <.001.