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The development of grit and growth mindset during adolescence

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Abstract

Individual differences in grit and growth mindset predict effort and achievement in the face of challenges, but little is known about how the two traits influence each other during adolescence. In the current investigation, we analyzed data on grit and growth mindset collected from 1667 adolescents and their teachers on four occasions over 2 academic years. In autoregressive cross-lagged models, grit predicted rank-order increases in growth mindset and growth mindset predicted rank-order increases in grit. These findings suggest that during adolescence, grit and growth mindset are distinct but mutually reinforcing.

Keywords

Grit; Growth mindset; Adolescents; Longitudinal; Autoregressive cross-lagged model; Reciprocal relation

Introduction

In recent decades, an array of positive personal attributes have emerged as important predictors of success in school and in life (Dweck, Walton, & Cohen, 2014; Farrington et al., 2012; Heckman & Kautz, 2014). Grit and growth mindset, in particular, have received attention from researchers and practitioners alike (for reviews, see Duckworth & Gross, 2014; Dweck, 2012; Eskreis-Winkler, Gross, & Duckworth, 2016; Yeager & Dweck, 2012). Surprisingly little is known about how these two attributes influence each other's development. Accordingly, we followed more than 1600 adolescents for 2 academic years, assessing grit at each of four assessment points with self-report questionnaires and teacher ratings and, in parallel, assessing growth mindset using self-report questionnaires.

Grit refers to the tendency to pursue long-term goals with steadfast dedication (Duckworth, Peterson, Matthews, & Kelly, 2007). Although orthogonal to intelligence (Duckworth et

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jecp.2020.104889.

al., 2007; Li et al., 2018), grit predicts the same achievement outcomes, including report card grades (*r*s = .25–.64; Duckworth et al., 2007; Park, Yu, Baelen, Tsukayama, & Duckworth, 2018), lifetime educational attainment (η^2s = .03–.05; Duckworth et al., 2007), job performance (*r*s = .21–.22; Ion, Mindu, & Gorbănescu, 2017; Mueller, Wolfe, & Syed, 2017), and retention (odds ratios [*OR*s] = 1.28–1.48; Eskreis-Winkler, Duckworth, Shulman, & Beal, 2014). Although largely influenced by genetic factors (Rimfeld, Kovas, Dale, & Plomin, 2016; Tucker-Drob, Briley, Engelhardt, Mann, & Harden, 2016), grit is not immutable. Like other personality traits (Kandler, 2012), grit can be altered by environmental factors (Alan, Boneva, & Ertac, 2019; Cross, 2014; Duckworth et al., 2007). For example, relative to their peers, middle school students who perceive their school cultures as emphasizing learning for the sake of learning demonstrate rank-order increases in grit that in turn predict rank-order improvements in report card grades (Park et al., 2018a).

There is some debate about the incremental predictive validity of grit over and above other related correlates, especially Big Five conscientiousness (Credé, Tynan, & Harms, 2017; Tucker-Drob et al., 2016; Ivcevic & Brackett, 2014; Rimfeld et al., 2016). However, grit is conceptually distinct from these related constructs because it specifies effort and interest toward especially long-term goals (Duckworth et al., 2007). Several studies have shown that grit provides incremental predictive validity for achievement outcomes over and above conscientiousness, particularly for goals of personal significance ((Duckworth, Peterson, Matthews, & Kelly, 2007; Duckworth & Quinn, 2009; Eskreis-Winkler, Shulman, & Duckworth, 2014)), not only in U.S. samples but also cross-culturally (Lee & Sohn, 2013, 2017; Suzuki, Tamesue, Asahi, & Ishikawa, 2015).

Notably, the nascent research literature on grit has evolved independently from growth mindset, the belief that intellectual ability is malleable rather than fixed (Dweck, 2008; Dweck & Leggett, 1988). Similar to grit, growth mindset also contributes to adaptive cognitive and behavioral outcomes. For example, individuals with more of a growth mindset tend to choose challenging tasks that help them to learn rather than easier options that minimize mistakes (Cimpian, Arce, Markman, & Dweck, 2007; Hong, Chiu, Dweck, Lin, & Wan, 1999). After experiencing a setback, students with a growth mindset tend to attribute their failure to lack of effort or ineffective learning strategies, whereas those with a fixed mindset are more likely to blame their lack of ability (*r* = .44; Blackwell, Trzesniewski, & Dweck, 2007; Dweck, 2000, 2008; Dweck & Leggett, 1988).

Several cross-sectional studies have shown that grit and growth mindset are positively correlated (*r*s = .13–.18; Hochanadel & Finamore, 2015; Tucker-Drob et al., 2016; West et al., 2016)—but not at levels approaching unity. Brain imaging studies also support this interpretation; although both grit and growth mindset are related to functional connectivity between regions involving cognitive-behavioral control, grit is associated with connectivity between regions related to future rewards, whereas growth mindset is associated with connectivity between regions involving error monitoring (Myers, Wang, Black, Bugescu, & Hoeft, 2016; Wang et al., 2018).

Recently, Duckworth (2016) proposed that growth mindset might lead to grit. How so? Dweck (2017) argued that an individual's lay belief about the malleability of personal

attributes (e.g., mindset about ability and personality) can mold an individual's worldview, goals, and actions. Thus, in identical situations, differing beliefs about the world and ourselves profoundly influence how we react (Beck & Freeman, 1994; Dweck, 2017). When people believe that their sweat and tears will pay off, they are more likely to set a long-term ambitious goal and persevere to meet it.

The reverse may also be true; grit might increase growth mindset. Gritty individuals are more likely to engage in deliberate practice, which in turn leads to improvements in skill (Duckworth, Kirby, Tsukayama, Berstein, & Ericsson, 2011). Over time, gritty individuals may "prove" to themselves through mastery experiences that hard work and challenge seeking will pay off. Indeed, a substantial body of research in clinical psychology suggests that changes in behaviors can precipitate changes in beliefs (e.g., Beck, Rush, Shaw, & Emery, 1979; Cuijpers, van Straten, & Warmerdam, 2007; Dimidjian et al., 2006). For example, in behavioral activation therapy for depression, changes in routine (e.g., going out to dinner, exercising) can lead to changes in thoughts and mood (Dimidjian et al., 2006; Gortner, Gollan, Dobson, & Jacobson, 1998; Jacobson et al., 2000). Thus, although never empirically examined, it is possible that passionate commitment to long-term goals helps individuals to believe in the malleability of ability.

A recent study (Alan et al., 2019) conducted randomized controlled trials to enhance elementary school students' grit by training classroom teachers. Compared with students in the control condition, those taught by teachers with training were more likely to seek challenging tasks and had higher academic grades and standardized test scores. The intervention included a message that ability is malleable as a function of effort, which is a hallmark of growth mindset. In other words, the intervention was based on *both* grit and growth mindset. A foundational assumption of grit intervention work is that grit and growth mindset are concomitantly and longitudinally related constructs; however, this assumption has never been empirically tested. Thus, the current investigation contributes to the existing literature by revealing (a) normative rank-order stability in grit and growth mindset over 2 academic years and (b) commitment and prospective effects between the two variables.

The current investigation

The development of positive attributes such as grit and growth mindset is important throughout life, but it is particularly critical during adolescence. During these formative years, stress tends to increase while self-esteem, perceived ability, school engagement, and grades decline (Fredricks, Blumenfeld, & Paris, 2004; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Sundblad, Jansson, Saartok, Renström, & Engström, 2008; Watt, 2004; Wigfield, Eccles, & Pintrich, 1996). Because such normative development can have lifelong consequences, it is important to explore personal attributes that can make students resilient and flourish during this period.

In a longitudinal study of adolescents, we repeatedly measured grit and growth mindset to test the hypothesis that the development of these personal attributes is mutually reinforcing. Our analyses of these data were driven by theory and the specific research questions of interest (Ferrer & McArdle, 2003; McArdle, 2009). Because we were interested in the stability of grit and growth mindset (e.g., whether grit measured at an earlier point in time

predicts grit at a later point in time) as well as dynamic relations between them (e.g., whether grit measured at an earlier point in time predicts growth mindset measured at a later point in time), we used autoregressive cross-lagged (ARCL) models.

Method

Participants

A sample of 1667 eighth graders (M_{age} = 13.75 years) from eight different middle schools in various states within the United States—California, Idaho, Pennsylvania, and Texas—were recruited for a larger longitudinal study on character development during adolescence.[1] About 89% of invited students participated in the study, and these students entered one of seven high schools during the second year of the current study. Based on school records, 49% of the students were female, 49% were African American, 24% were White, 15% were Hispanic, 10% were Asian, and 2% were categorized as "other." About 66% of the participating students qualified for free or reduced-price meals. Based on data collected from the National Center for Education Statistics (2017) database, our sample was representative of the school populations from which it was drawn. Across four time points, a total of 145 teachers participated in the study. On average, students were rated by 2.57 teachers and each teacher rated 69.74 students. Student data were retained for all individuals who provided information for at least one variable included in the analyses in order to maximize available data.

Procedure and measures

Data collection took place in the fall of eighth grade (Time 1 [T1]), spring of eighth grade (T2), fall of ninth grade (T3), and spring of ninth grade (T4), spaced approximately 6 months apart. Students who were not available during T1 were allowed to participate if the parents and students gave their assent at each time of data collection. All participants took the survey using school laptops under the supervision of either a teacher or a researcher.

Grit—Using a 5-point Likert response scale ranging from 1 = *never* to 5 = *always,* students completed five age-appropriate items adapted from the original Grit Scale (Duckworth et al., 2007), and we averaged the five items to create self-reports of grit for each time point. These items tapped sustained passion ("I stuck with a project or activity for more than a few weeks" and "I stayed committed to my goals even if they took a long time to complete") and perseverance ("I finished whatever I started," "I tried very hard even though I failed," and "I kept working hard even if I felt like quitting") and were preceded by the prompt to reflect on their behavior "in the last month" (for evidence of validity, see Park et al., 2018a). The observed alphas were .73 (T1), .75 (T2), .75 (T3), and .77 (T4).

[1]The current data are part of a larger project. The goal of the larger project was to advance the measurement and understanding of character development (e.g., grit, growth mindset, self-control, gratitude) in adolescents. The primary substantive aims of the project were (a) to examine the impact of character strengths on academic success, social functioning, and psychological well-being and (b) to examine potential interactions and overlap among character strengths. Subsets of the data have been used in prior work (Galla, Tsukayama, Park, Yu, & Duckworth, 2020; Park, et al., 2018a, 2018b); however, the research hypotheses, reported analyses, and conclusions made in this article do not overlap with these other articles.

In parallel, teachers of four major classes—English, math, science, and social studies—were asked to rate each student on a single item using the same response scale (Park et al., 2018a; Park, Tsukayama, Goodwin, Patrick, & Duckworth, 2017). Specifically, teachers saw the identical five grit items that students filled out about themselves and provided one global rating of grit for each student. Because teacher ratings of the same students demonstrated high intraclass correlation coefficients—.83 (T1), .86 (T2), .83 (T3), and .82 (T4)—we averaged across teacher ratings for each student at each time point to create a composite teacher rating of grit.

The correlations between student and teacher ratings ranged from .25 to .30 across the four time points, which compares favorably to a meta-analysis of child self-report and informant ratings (r = .22; Achenbach, McConaughy, & Howell, 1987). We then averaged the composite teacher rating with mean self-reports from students to create composite grit scores, following common practice (Duckworth & Seligman, 2005; Duckworth & Yeager, 2015; Eid & Diener, 2006; Park et al., 2017, 2018a).

Growth mindset

Using a 6-point Likert scale ranging from 1 = *strongly disagree* to 6 = *strongly agree,* students completed three items from Dweck (2000): “You have a certain amount of intelligence, and you really can’t do much to change it,” “Your intelligence is something about you that you can’t change very much,” and “You can learn new things, but you can’t really change your basic intelligence.” All items were reverse coded so that a higher score represented higher growth mindset endorsement. The observed alphas were .81 (T1), .86 (T2), .89 (T3), and .89 (T4). Because beliefs are internal and, therefore, not possible for teachers to observe directly (Vazire, 2010), teachers were not asked to rate their students on growth mindset.

Cognitive ability

Based on the prior work indicating that grit and growth mindset have nonsignificant or (sometimes) negative correlation with cognitive ability (Duckworth et al., 2007; Macnamara & Rupani, 2017), we included IQ scores as a covariate. To measure IQ, we used the Mill Hill Vocabulary Scale (Raven, 1965). Adolescents were given 32 words and asked to select the correct synonym for each word from a choice of six words. The Mill Hill Vocabulary Test is highly correlated (rs > .90) with other valid IQ tests (for a review, see Raven, Court, & Raven, 1987).

Demographic covariates—In addition, for each student, we obtained gender, ethnicity, free or reduced-price meal status, and school affiliation[2] from school records.

[2]Because the middle school students moved to different classrooms at school and multiple teachers (English, social studies, science, and math) rated their grit, we were not able to analyze data at the classroom level. Furthermore, prior studies suggest that at least 25 to 30 clusters are needed to conduct random-effects multilevel structure models (Maas & Hox, 2005; Paterson & Goldstein, 1991; Snijders & Bosker, 2000). Therefore, to adjust for clustering, we used fixed effects by dummy coding the school variables and controlling for them in all analyses (Allison, 2009).

Results

Analytic strategy

We analyzed the data using Mplus 7 (Muthén & Muthén, 2012). For the ARCL models, we first examined the least constrained baseline model, where the autoregressive and cross-lagged effects were allowed to vary over time. Then we examined models constraining the cross-lagged and autoregressive paths across time points, respectively. We performed chi-square difference tests to determine the final model. For all models, demographic covariates (gender, ethnicity, lunch status, and school affiliation) and cognitive ability were controlled. The average missingness rate from all variables included in the current analyses was about 8.6%; thus, we used full information maximum likelihood estimation, which is less biased and more efficient than traditional missing data techniques (Collins, Schafer, & Kam, 2001; Enders & Bandalos, 2001; Peters & Enders, 2002).

Descriptive statistics

Table 1 displays the means, standard deviations, and bivariate correlations of the main variables. Grit (rs = .53–.75) and growth mindset (rs = .39–.58) demonstrated moderate to large rank-order stability over 2 years. Consistent with prior research (Tucker-Drob et al., 2016; West et al., 2016; Yeager et al., 2016), grit and growth mindset were moderately correlated at each wave and, in addition, across waves (rs = .18–.23).

Cross-lagged relations between grit and growth mindset

We first examined an unconstrained baseline model (M1) and then added constraints on cross-lagged paths (M2), autoregressive paths (M3), and both cross-lagged and autoregressive paths simultaneously (M4) to find the most parsimonious model. Table 2 presents the fit statistics of each of the four models. To choose the most parsimonious yet best fitting model, we used chi-square differences (Satorra & Bentler, 2001) as well as differences in comparative fit index (CFI) and root mean square error of approximation (RMSEA) to compare model fit. Prior work (Chen, 2007) suggests that two models can be assumed to be equal when a change in CFI is ≤ .01 and a change in RMSEA is ≤ .015. Based on these criteria, we chose M2, in which the cross-lagged paths were time invariant, as our final model.

As shown in Fig. 1, all autoregressive paths (bs = .45–.81) were significant (ps < .001), suggesting that grit and growth mindset demonstrate substantial rank-order stability. Nevertheless, the cross-lagged paths from grit to growth mindset were also significant (average $\beta = .07$, $b = .13$, $SE = .03$, $p < .001$), and the paths from growth mindset to grit were also significant (average $\beta = .03$, $b = .02$, $SE = .01$, $p < .01$). This suggests that grit and growth mindset reciprocally predicted each other's developmental trajectories.[3] Exploratory

[3]We used different raters (i.e., teachers paired with each child) to assess grit primarily because a multisource measurement approach increases reliability and validity, with different sources contributing complementary information about the behavior or trait of interest Duckworth & Yeager, 2015; Park et al., 2017; Roberts, Walton, & Viechtbauer, 2006; Tsukayama, Duckworth, & Kim, 2013). In addition, to examine the validity of the combined grit scale, we ran a confirmatory factor analysis with student and teacher ratings as indicators, which fit the data well, $\chi^2(24) = 33.605$, $p > .09$, RMSEA = .016, CFI = .999, standardized root mean square residual (SRMR) = .014. We also ran separate ARCL models with student- and teacher-rated scales. In the student-rated analysis, the model did not fit the data well, $\chi^2(16) = 259.32$, $p < .001$, RMSEA = .096, CFI = .914, SRMR = .026. The grit-to-growth-mindset paths were

analyses revealed no reliable and systematic moderation effects by demographic covariates (gender, ethnicity, and socioeconomic status; see online supplementary material for details).

Discussion

In a longitudinal study of adolescents, grit and growth mindset reciprocally predicted each other's development. This pattern of results was consistent across four consecutive waves of data collection and did not vary by gender, ethnicity, or socioeconomic status. To our knowledge, this investigation is the first to examine the longitudinal development of personal attributes that have, in separate research studies, been shown to predict academic achievement.

We were somewhat surprised that these effects were not symmetrical; the predictive validity of grit for growth mindset (average $\beta = .07$) was twice that of growth mindset for grit (average $\beta = .03$). Although the influence of beliefs on behavior is perhaps more intuitive, our findings are in line with clinical research suggesting that changes in behavior can markedly influence cognitive changes (Beck et al., 1979). Moreover, Bandura (1993) suggested that mastery experiences are key to developing agentic beliefs about one's capabilities. In other words, believing in your own intellectual ability may influence your actions, but past successes may have led to that confidence in your ability in the first place.

Although this study is the first of its kind examining longitudinal relations between grit and growth mindset, it has limitations. For example, future research is needed to determine how beliefs about the malleability of abilities other than intelligence relate to grit. Although beliefs about intelligence are particularly identity relevant (Dweck, 2000), a growth mindset about intelligence does not imply a growth mindset in other domains (Dweck, Chiu, & Hong, 1995; Hughes, 2015). In the current work, growth mindset refers to the domain of intelligence, whereas grit refers to goals more generally. Such differences in measured domains may explain the small effect sizes of the current work, and the effect might be strengthened if the growth mindset and grit measures were assessed at the same level of specificity.

Regarding the small effect sizes, another potential explanation could be the analytic approach we took. In ARCL models, prior levels of outcomes are controlled. Although controlling for past levels of outcomes (stability effect) enables us to interpret the results in developmentally meaningful ways, controlling for the stability effects often makes the effect of predictors on outcome appear to be small because the stable individual difference often accounts for most of the total variance. It is important to keep in mind that standardized coefficients smaller than .10 in autoregressive models are meaningful, especially when there is strong stability in the outcome variable (Adachi & Willoughby, 2015).

not statistically significant (average $\beta = .02$, $p > .20$), and the growth-mindset-to-grit paths did not reach the threshold of statistical significance (average $\beta = .03$, $p = .05$). In the teacher-rated analysis, the model fit the data reasonably well, $\chi^2(16) = 252.01$, $p < .001$, RMSEA = .096, CFI = .952, SRMR = .023. Both grit-to-growth-mindset paths (average $\beta = .09$, $p < .001$) and growth-mindset-to-grit paths (average $\beta = .02$, $p < .05$) were statistically significant. Both empirical evidence and theory support composite scores as better measures of grit; thus, we use composite scores to interpret our main findings.

Another remaining question of the current work is whether the observed effect is driven more by the passion or the perseverance component of grit. In our scale, only a limited number of passion and perseverance items were used for student ratings, so our dataset is not ideal for testing such a question. But conceptually, believing in the malleability of ability would more likely encourage the continued effort to achieve a goal despite difficulties than having a sustained passion for a goal. Empirical data (Credé et al., 2017) also suggest that the perseverance component of grit has stronger predictive validity. Thus, it is possible that the perseverance component of grit resulted in the findings here; future research is needed to empirically confirm this speculation.

Most important, the correlational nature of our data limits causal inference. The observation that grit and growth mindset predict subsequent rank-order changes does not mean that one attribute increases the other. We cannot rule out the possibility of unmeasured third-variable confounds—including environmental influences—that might account for the codevelopment of both grit and growth mindset. For instance, it may be that adolescents whose parents or teachers encourage them to frame failure as an opportunity for learning manifest rank-order increases in both grit and growth mindset (Haimovitz & Dweck, 2016). This limitation underscores the need for experimental investigation; as noted by Walter Dearborn, “If you want to understand something, try to change it” (cited in Bronfenbrenner, 1979, p. 37).

Several intervention approaches (Walton, 2014) have now been shown to increase growth mindset and academic achievement (Aronson, Fried, & Good, 2002; Blackwell et al., 2007; Good, Aronson, & Inzlicht, 2003; Paunesku et al., 2015; Yeager et al., 2016), and these benefits have been replicated in a preregistered, nationally representative sample (Yeager et al., 2019). Unfortunately, much less is known about how to develop grit. Specifically, whereas a handful of interventions have successfully increased effort and academic achievement in convenience samples of adolescents (Eskreis-Winkler et al., 2016; Yeager, Bundick, & Johnson, 2012), almost nothing is known about how to increase long-term commitment to goals. One recent study indicated that individuals have different beliefs about the origins of passion (O’Keefe, Dweck, &Walton, 2018); compared with individuals with a fixed theory of interest, those with a growth theory of interest were more likely to maintain interest in the face of difficulty. Thus, an intervention targeting beliefs about passion could be a fruitful direction of a future grit intervention.

A prominent economic theory of human capital development has proposed that personal attributes such as grit and growth mindset can be “self-reinforcing and cross-fertilizing” and suggests that “higher stocks of skills in one period create higher stocks of skills in the next period” (Cunha & Heckman, 2007, pp. 35–36). In our investigation, we found empirical evidence for such a virtuous cycle. Relative to same-age peers, adolescents who believed that intellectual ability is malleable subsequently worked steadfastly toward challenging goals even after accounting for their prior beliefs. To an even greater degree, the converse was also true; higher measured grit predicted subsequent rank-order increases in growth mindset. These reciprocal relationships suggest that “psychologically wise interventions” (Walton & Wilson, 2018), particularly during early adolescence, may precipitate upward spirals in adaptive beliefs and behavior.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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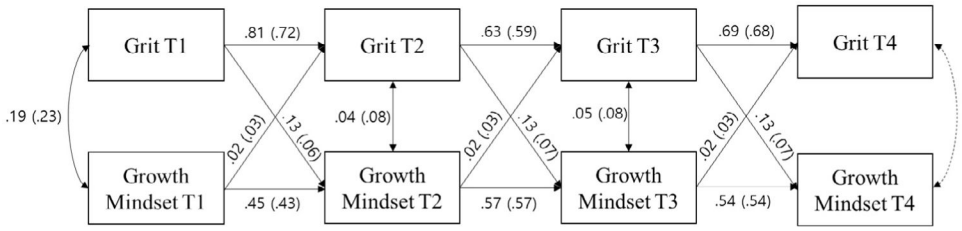

Fig. 1.

Autoregressive cross-lagged panel model showing longitudinal relations between grit and growth mindset. Unstandardized coefficients are reported with standardized coefficients in parentheses. Demographic information is controlled in all paths but is not shown for interpretability and parsimony. The covariance between the T4 variables was estimated but was not significant ($p = .20$). T1/2/3/4, Time 1/2/3/4.

Table 1

Means, standard deviations, and correlations of the main variables.

Variable		*M*	*SD*	1	2	3	4	5	6	7
1.	Grit, T1	3.66	0.65	–						
2.	Grit, T2	3.53	0.72	.75	–					
3.	Grit, T3	3.53	0.76	.56	.63	–				
4.	Grit, T4	3.52	0.76	.53	.60	.72	–			
5.	Growth mindset, T1	4.04	1.28	.23	.18	.17	.18	–		
6.	Growth mindset, T2	4.08	1.32	.19	.19	.19	.20	.46	–	
7.	Growth mindset, T3	4.11	1.32	.21	.22	.22	.21	.42	.58	–
8.	Growth mindset, T4	4.09	1.33	.18	.19	.18	.18	.39	.50	.55

Note. All correlations were significant at $p < .001$. T1/2/3/4, Time 1/2/3/4.

Table 2

Fit indices and model comparisons for cross-lagged panel regression models.

	Model fit indices					Comparison with M1		
	χ^2	*df*	CFI	RMSEA	BIC	$\Delta\chi^2$	Δdf	*p*
M1: Baseline	187.02	12	.96	.09	36412.00			
M2: Time-invariant cross lag paths	191.05	16	.96	.08	36386.36	4.03	4	.40
M3: Time-invariant autoregressive paths	230.74	16	.95	.09	36426.05	43.72	4	<.001
M4: M2 + M3	233.66	20	.95	.08	36399.29	46.64	8	<.001

Note. M1/2/3/4, Model 1/2/3/4; CFI, comparative fit index; RMSEA, root mean square error of approximation; BIC, Bayesian information criterion.