Singapore Longitudinal Early Development Study (SG LEADS)

Panel Survey Wave 2

Technical Report 5

Delay of Gratification Task in SG LEADS Wave 2

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The Delay of Gratification (DoG) choice paradigm was used in both Wave 1 and Wave 2 of the Singapore Longitudinal EArly Development Study (SG LEADS). This technical report documents the developmental trajectory of DoG among children aged 3 to 9, in Wave 2, and discusses its reliability and validity.

In Wave 2, we used the same choice paradigm as W1 (see Wave 1 Technical Report 4 for details) to measure children's ability to delay gratification. Different designs within the same type of rewards were used in the two waves (e.g., Strawberry, orange, and kiwi erasers were used in Wave 1, and grapes, dragon fruits, and watermelon erasers were used in Wave 2).

In the second wave of SG LEADS, we measured delay of gratification in 3,016 children (47.9% girls) aged 3-6 years (M_{age} = 59.4 months, *SD* = 14.2). Among these children, 67.9% were Chinese, 16.2% were Malays, 11.4% were Indians, and 4.5% were from other ethnic backgrounds. The majority (78.9%) spoke English as their primary language, followed by Mandarin (14.6%), Malay (4.0%), Tamil (1.6%), and other languages (0.9%). Children's family socioeconomic status (SES) was classified as three categories based on their primary caregivers' education levels, namely, Low-SES (secondary school and below; 23.4%), Middle-SES (post-secondary, polytechnic diploma or other diploma; 29.9%), and High-SES (bachelor's and above; 46.6%).

The choice of delayed reward in each test trial was scored as '1', while the choice of immediate reward was scored as '0'. The total score of nine trials, ranging from 0 to 9, indicated children's ability to delay gratification. Please refer to Table 1 for the mean scores by age, gender, SES, as well as types of reward and types of choice.

Table 1. Mean scores of Delay of Gratification by age, gender, SES, types of reward and types of choice

Age	3 years (*n*=795)	4 years (*n*=721)	5 years (*n*=723)	6 years (*n*=758)	Total (*n*=2998)
Gender					
Boy	3.86 (3.72)	4.14 (3.61)	5.88 (3.30)	6.54 (3.20)	5.15 (3.64)
Girls	4.17 (3.81)	4.94 (3.66)	6.00 (3.31)	6.70 (2.80)	5.38 (3.58)
SES					
Low	3.73 (3.62)	4.03 (3.56)	5.14 (3.50)	5.70 (3.26)	4.61 (3.63)
Middle	3.78 (3.70)	4.31 (3.61)	5.91 (3.41)	6.72 (3.04)	5.15 (3.60)
High	4.25 (3.74)	4.93 (3.65)	6.31 (3.31)	6.89 (2.88)	5.55 (3.57)
Types of Reward					
Balloons	1.32 (1.31)	1.45 (1.31)	1.98 (1.20)	2.17 (1.12)	1.72 (1.29)
Stickers	1.37 (1.34)	1.57 (1.32)	2.02 (1.19)	2.19 (1.13)	1.78 (1.29)
Erasers	1.34 (1.34)	1.53 (1.29)	1.94 (1.20)	2.25 (1.10)	1.76 (1.29)
Types of Choice					
1 now vs. 2 later	1.32 (1.29)	1.48 (1.29)	1.95 (1.19)	2.18 (1.09)	1.67 (1.28)
1 now vs. 4 later	1.28 (1.31)	1.63 (1.26)	1.97 (1.19)	2.26 (1.00)	1.78 (1.25)
1 now vs. 6 later	1.37 (1.33)	1.54 (1.28)	2.01 (1.16)	2.21 (1.10)	1.78 (1.27)
Total	3.99 (3.77)	4.55 (3.65)	5.81 (3.34)	6.55 (3.06)	5.26 (3.61)

Note. Standard deviations are presented in the parentheses.

Internal Reliability

First of all, to examine the internal reliability of the choice paradigm, we computed Cronbach's alphas of the nine trials in the whole sample and across different characteristics of children. The delay of gratification choice paradigm exhibited excellent internal consistencies in the whole sample (Cronbach's α = .94), and across ethnicity (Chinese: α = .94; Malay: α = .94; Indian: α = .92, and Others: α. = 94), gender (Boys: α = .94; Girls: α = .93), age (3 years: α = 0.95; 4 years: α = 0.94; 5 years: α = 0.92; 6 years: α = 0.91), and SES (Low: α = 0.93; Middle: α = 0.93; High: α = 0.94). The internal consistencies of different types of reward (Balloons: α = .84 Stickers: α = .85; Erasers: α. = 84) and types of choice (1 now vs. 2 later: α = .82; 1 now vs. 4 later: α = .82; 1 now vs. 6 later: α = .83) were all in the Good range. Therefore, the delay of gratification choice paradigm possessed good internal reliability in the current sample.

Second, we examined whether children made any distinction among the varying types of choice and types of reward, by using three-way between- and within-subjects mixed analysis of variance (ANOVA). Within-subjects variables in the two ANOVAs were type of choice (3: 1vs.2, 1vs.4, and 1vs.6) and type of reward (3: balloon, sticker, and eraser), respectively. Between-subjects variables were age (4: 3yrs, 4yrs, 5yrs, and 6yrs) and gender (2: boys and girls) in both ANOVAs. The type of choice showed a significant main effect ($F(2, 2737) = 6.58$, $p = .001$, $\eta^2 = .005$) and a significant interaction effect with gender ($F(2, 5476) = 3.72$, $p = .02$, $\eta^2 = .003$). The rest of interaction effects were not significant (*ps* > .10). In general, in *1 now vs. 6 later* trials, children were more likely to choose delayed rewards than were they in *1 now vs. 4 later* trials ($p = .03$) and *1 now vs. 2 later* trials ($p < .001$). More specifically, the effect of choice type on delay of gratification was only significant in boys (*ps* were < .001 and .003, respectively), but not in girls (*ps* > .10). As for the effects of reward type, we observed a significant main effect ($F(2, 2737) = 6.69$, $p = .001$, $\eta^2 = .002$), and significant interaction effects with age ($F(6, 5476) = 3.00$, $p = .006$, $\eta^2 = .003$) and gender ($F(2, 5476) = 11.4$, $p < .001$, $\eta^2 = .004$). In general, children were less likely to choose delayed reward in the *balloons* trials, compared to *sticker* trials ($p < .001$) and *eraser* trials ($p = .02$). To be specific, the effect of reward type was found in boys (*ps* were .001 and <.001) but not in girls (*ps* > .10); and it was only found in 4-year-olds (*ps* were < .001 and .01) but not in other age groups (*ps* > .10). The variation in choices by reward type can be explained by the attractiveness of the rewards to children. Indeed, 52.4% and 51.6% of children ranked balloons as their most favourite reward, before and after the test trials, respectively; whereas the other half split their votes to stickers and erasers.

Taken together, girls and older children (aged 5 and above) did not make any distinction among the varying types of choice and types of reward. In contrast, in boys, when the reward is more appealing, or when the value of delayed reward is larger, they were less likely to delay gratification.

Table 2. Three-Way mixed ANOVA Results

	SS	*df*	*MS*	*F*	*p*	η^2
(1) Type of Choice						
Type of Choice	3.51	2	1.76	7.21	**.001**	.003
Age	1012.9	3	337.6	85.1	**<.001**	.09
Gender	27.5	1	27.5	6.92	**.009**	.003
Choice x Age	1.63	6	0.27	1.12	.35	.001
Choice x Gender	1.74	2	0.87	3.57	**.028**	.001
Age x Gender	16.1	3	5.35	1.35	.26	.001
Choice x Gender x Age	2.74	6	0.46	1.88	.081	.002
Residual	10868.7	2738	3.97			
(2) Type of Reward						
Type of Reward	4.37	2	2.19	6.69	**.001**	.002
Age	1012.9	3	337.6	85.1	**<.001**	.09
Gender	27.5	1	27.5	6.92	**.009**	.003
Reward x Age	5.89	6	0.98	3.00	**.006**	.003
Reward x Gender	7.45	2	3.73	11.4	**<.001**	.004
Age x Gender	16.1	3	5.35	1.35	.26	.001
Reward x Gender x Age	1.34	6	0.22	0.68	.66	.001
Residual	10868.7	2738	3.97			

Furthermore, we investigated the developmental trajectories of delay of gratification in our sample. A three-way between-subjects ANOVA, 4 (age: 3, 4, 5 vs. 6) x 2 (gender: boy vs. girl) x 3 (SES: high, middle, vs. low), was performed to examine the effects of age, gender, and SES on delay of gratification. As shown in Table 3, we observed a significant main effect of age ($F(3, 2722) = 69.2$, $p < .001$, $\eta^2 = .07$), a significant main effect of gender ($F(1, 2722) = 6.52$, $p = .011$, $\eta^2 = .002$), and a significant main effect of SES ($F(2, 2722) = 15.7$, $p < .001$, $\eta^2 = .01$). As expected, (1) girls were more likely to choose delayed reward than boys; (2) young children's ability to delay gratification significantly increased with age, and the differences were observed between all the age groups (*ps* were from <.001 to .005); and (3) children with higher SES background showed higher levels of delay of gratification than their peers with lower SES background, and the differences were found between all the SES groups (*ps* were from <.001 to .028). None of the interaction effects was significant (*ps* > .10), indicating that the effects of age, gender and SES did not vary by one another. For example, as displayed in Figure 3 and Figure 4, the development of Delay of Gratification with age was observed across genders and SES levels. To some extent, our results supported the literature about the influences of age, gender and SES on delay of gratification (Evans & English, 2002; Imuta, Hayne, & Scarf, 2014; Silverman, 2003).

We further investigated the development of delay of gratification with age in more detail. The *T*-tests results showed that 3-year-olds showed strong preference for immediate small rewards (i.e., the choice of delayed rewards was significantly below the chance level, $t(794) = -3.78$, $p < .001$), 4-year- olds chose delayed reward in near half of the test trials ($t(721) = -0.36$, $p = .72$), and 5- and 6-year-olds showed strong preference for delayed larger rewards (i.e., they chose delayed rewards in more than half of the test trials, $t(723) = 10.5$, $p < .001$, and $t(758) = 18.5$, $p < .001$, respectively). These findings suggested that delay of gratification developed rapidly in early children, and children generally were not able to delay gratification at age 3.

Table 3. Three-Way ANOVA Results

	SS	*df*	*MS*	*F*	*p*	η^2
Gender	76.8	1	76.8	6.52	**.01**	.002
Age	2446.8	3	815.6	69.2	**<.001**	.07
SES	370.2	2	185.1	15.7	**<.001**	.01
Gender x Age	45.99	3	15.3	1.30	.27	.001
Gender x SES	0.93	2	0.46	0.04	.96	<.001
Age x SES	54.5	6	9.08	0.77	.59	.002
Gender x Age x SES	90.9	6	15.2	1.29	.26	.003
Residual	32078.6	2722	11.8			

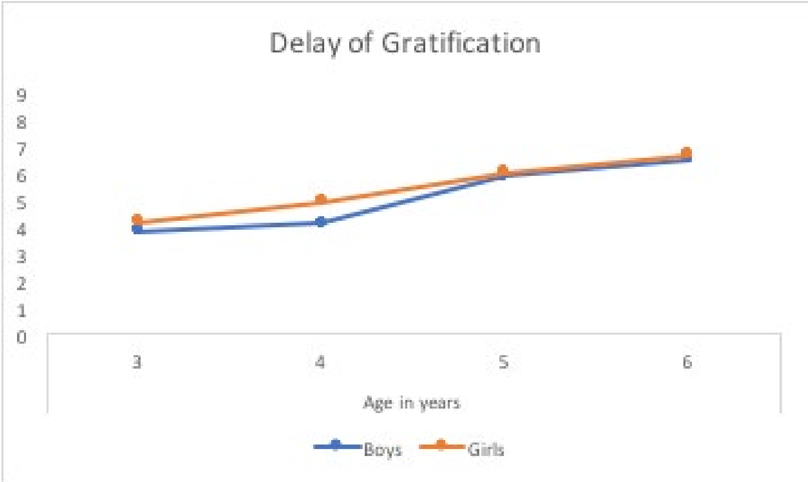

Figure 3. Developmental trajectory in delay of gratification with age and gender

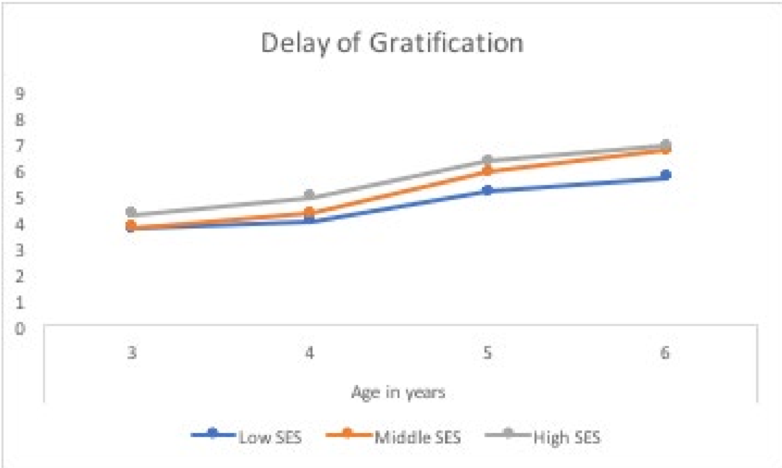

Figure 4. Developmental trajectory in delay of gratification with age and SES

Convergent Validity

To establish the convergent validity of the choice paradigm, we examined the correlations of delay of gratification with other theoretically related constructs such as self-control and executive function (collectively referred to as cognitive control). As shown in Table 3, children's delay of gratification was moderately correlated with self-control rated by their primary caregivers ($r = .20$, $p < .001$), and positively correlated with working memory which was measured by forward and backward digit span tasks ($r = .33$, $p < .001$, and $r = .32$, $p < .001$, respectively). These results suggested that the delay of gratification choice paradigm possessed a good convergent validity as a self-control measure.

Table 3. Bivariate correlations between delay of gratification and outcome variables in children aged 3 to 6

	DoG	Self-Control	FWM	BWM	EXT	INT	LW	PC	AP	CL
DoG	-	.20***	.33***	.32***	-.004	-.001	.31***	.33***	.38***	.31***
Self-Control		-	.20***	.23***	-.24***	-.21***	.23***	.18***	.20***	.23***
FWWM			-	.63***	-.05*	-.01	.67***	.62***	.70***	.57***
BWWM				-	-.06**	-.02	.64***	.62***	.63***	.66***
EXT					-	.65***	-.03	-.04*	-.07***	-.05**
INT						-	.01	.02	-.03+	.002
LW							-	.82***	.81***	.71***
PC								-	.80***	.68***
AP									-	.67***
AL										-
M	5.21	3.56	6.47	2.22	5.33	1.98	373.1	391.2	414.1	401.7
SD	3.61	0.75	3.48	2.64	4.52	3.24	54.3	51.1	37.6	36.4
N	2997	2988	2997	2997	2993	2993	2987	2987	2987	2987

Note. DoG = Delay of Gratification. FWM = Forward Working Memory. BWM = Backward Working Memory. EXT = Externalizing behavior problems. INT = Internalizing behavior problems. LW = Letter-Word Identification. PC = Passage Comprehension. AP = Applied Problems. CL = Calculation. ****p* < .001. ***p* < .01. **p* < .05. +*p* < .10.

Predictive Validity

The predictive validity of the choice paradigm was obtained by examining the correlations between delay of gratification and concurrently measured outcomes such as behaviour problems and academic achievement. As expected, delay of gratification was positively correlated with academic performance in standardized reading tests (e.g., letter-word identification and passage comprehension) and math tests (e.g., applied problem and calculation). Contrary to our expectation, in the whole sample, delay of gratification was correlated with neither externalizing behaviour problems nor internalizing behaviour problems. Given that 3-year-olds generally haven't developed Delay of Gratification, we examined the predictive power of delay of gratification to outcomes in 4- to 6-year-olds. As displayed in Table 4, in children between 4 and 6, delay of gratification was negatively correlated with externalizing behaviour problems, and positively correlated with academic performance in both reading and math.

Table 4. Bivariate correlations between delay of gratification and outcome variables in children aged 4 to 6

	DoG	Self-Control	FWWM	BWWM	EXT	INT	LW	PC	AP	CL
DoG	-	.17***	.32***	.30***	-.05*	-.03	.28***	.29***	.37***	.29***
Self-Control		-	.22***	.23***	-.23***	-.21***	.25***	.19***	.24***	.24***
FWWM			-	.61***	-.04*	-.05*	.59***	.55***	.63***	.51***
BWWM				-	-.06**	-.06**	.58***	.56***	.60***	.59***
EXT					-	.68***	-.008	-.04*	-.07**	-.05*
INT						-	-.02	.03	-.08***	-.04*
LW							-	.81***	.78***	.69***
PC								-	.76***	.63***
AP									-	.65***
AL										-
M	5.65	3.60	7.41	2.90	5.29	2.11	389.4	406.5	425.1	412.4
SD	3.45	0.75	3.11	2.69	4.54	3.42	50.6	46.2	32.7	36.4
N	2203	2204	2203	2203	2204	2204	2200	2200	2200	2200

Note. DoG = Delay of Gratification. FWM = Forward Working Memory. BWM = Backward Working Memory. EXT = Externalizing behavior problems. INT = Internalizing behavior problems. LW = Letter-Word Identification. PC = Passage Comprehension. AP = Applied Problems. CL = Calculation. ****p* < .001. ***p* < .01. **p* < .05.

Furthermore, Structural Equation Modelling (SEM) was performed to confirm the predictive validity of this choice paradigm by examining the multivariate correlations between delay of gratification and outcome variables. In the first model, delay of gratification acted as the predictor, and outcome variables included externalizing behaviour problems, internalizing behaviour problems, and academic performance in the four standardized tests. Age, gender, SES (primary caregiver's education level), and primary language were entered as covariates. As illustrated in Figure 5, the association of delay of gratification with academic and behavioral outcomes held when controlling for covariates. To be specific, delay of gratification was still associated with higher scores in reading tests (letter-word: $\beta = .04$, $SE = .005$, $p < .001$; passage comprehension: $\beta = .04$, $SE = .005$, $p < .001$) and math tests (applied problem: $\beta = .06$, $SE = .005$, $p < .001$; calculation: $\beta = .03$, $SE = .005$, $p < .001$), as well as fewer externalizing behavior problems ($\beta = -.02$, $SE = .006$, $p = .02$). Because this model was just-identified and only included observed variables, model fit statistics were not available. The predictive power of the delay of gratification choice paradigm was somewhat consistent with that of the classic maintenance paradigm, better known as “marshmallow test”, to academic and behavioral outcomes (e.g., (Duckworth et al., 2013). Taken together, the delay of gratification choice paradigm possessed a good predictive validity.

Finally, we examined whether the predictive power of delay of gratification to behavioural and academic outcomes mainly derived from self-control or cognitive function. In the second SEM, self-control and working memory were entered as mediators in the association between delay of gratification and the outcome variables. Model 2 obtained an adequate model fit: $\chi^2(1) = 78.6$, $p < .001$; CFI = 0.99, RMSEA = 0.08 (90% CI = [.16, .23]), and SRMR = 0.02. As illustrated in Figure 6, children with higher levels of delay of gratification were rated as higher in self-control ($\beta = .04$, $SE = .006$, $p < .001$) and performed better in working memory task ($\beta = .07$, $SE = .005$, $p < .001$). The predictive power of delay of gratification to externalizing and internalizing behavior problems was mainly explained by self-control (indirect effects: $\beta = -.009$, $SE = .002$, $p < .001$, and $\beta = -.008$, $SE = .001$, $p < .001$, respectively), but not by cognitive function (indirect effect: $\beta = .001$, $SE = .002$, $p = .48$, and $\beta < .001$, $SE = .10$, $p = .92$, respectively). The predictive power of delay of gratification to academic performance in reading and math was in part accounted for by working memory (indirect effects: $\beta = .32$, $SE = .03$, $p < .001$, for both), and marginally by self-control (indirect effects: $\beta = .001$, $SE = .001$, $p = .09$, and $\beta = .001$, $SE = .001$, $p = .08$, respectively). Our results were consistent with previous findings that the predictive power of delay of gratification to behavior problems primarily derived from self-control (Duckworth et al., 2013), and cognitive function was a better predictor of standardized achievement tests scores than self-control (Duckworth, Quinn, & Tsukayama, 2012).

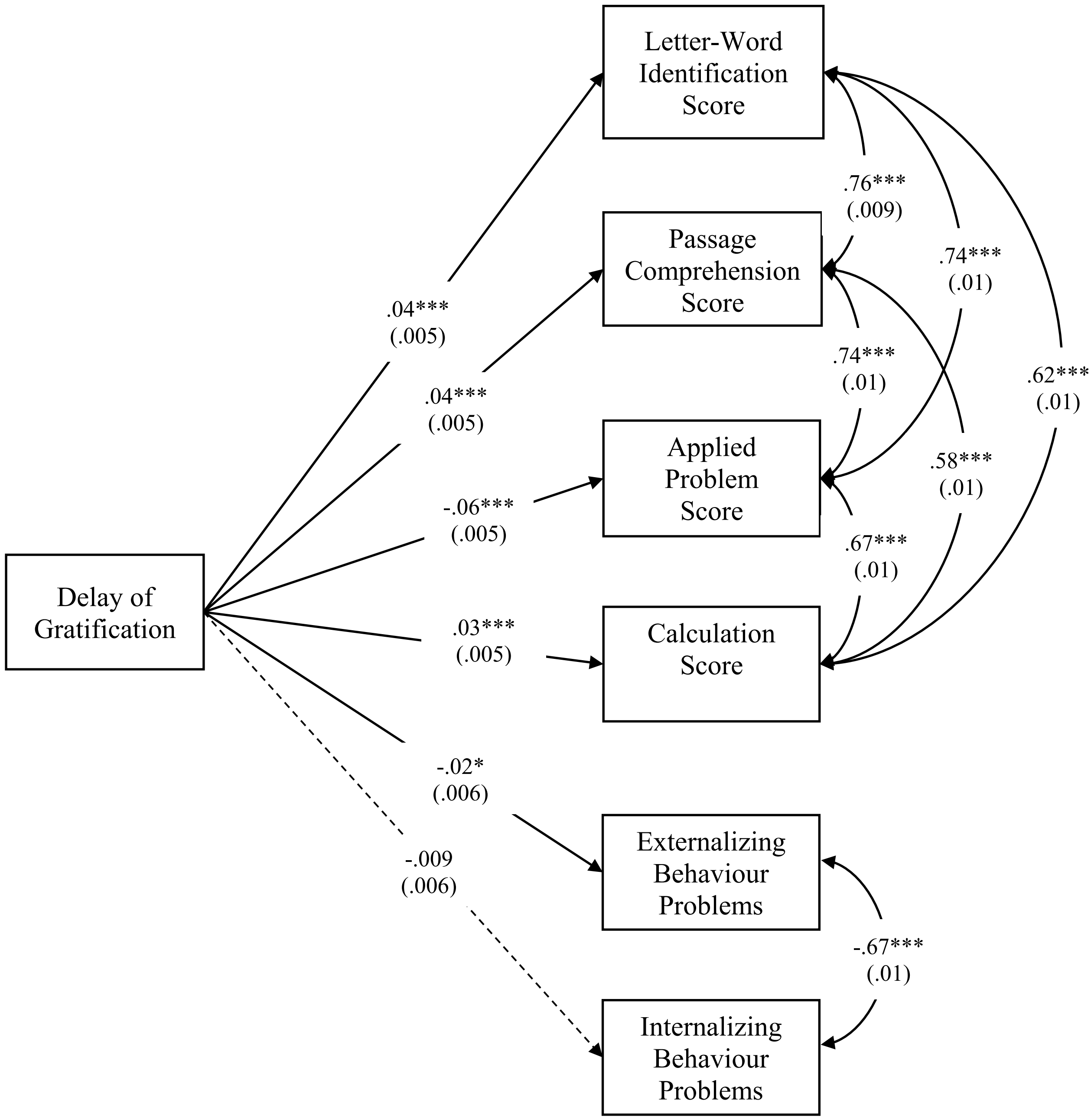

Figure 5. The Predictive Power of Delay of Gratification to Academic Performance and Behaviour Problems.
Note. Age, gender (dummy coded as 1=girl, 0=boy), SES, primary language (dummy coded as 1=English, 0=Non-English) were covariates.

To sum up, the delay of gratification choice paradigm possesses (1) sensitivity to investigating the developmental trajectories with age, gender and parental education level, (2) excellent internal reliability, (3) good convergent validity with self-control, and (4) predictive validity to concurrently measured behavioural and academic outcomes. The predictive power of Delay of Gratification mainly derived from self-control, over and beyond cognitive function.

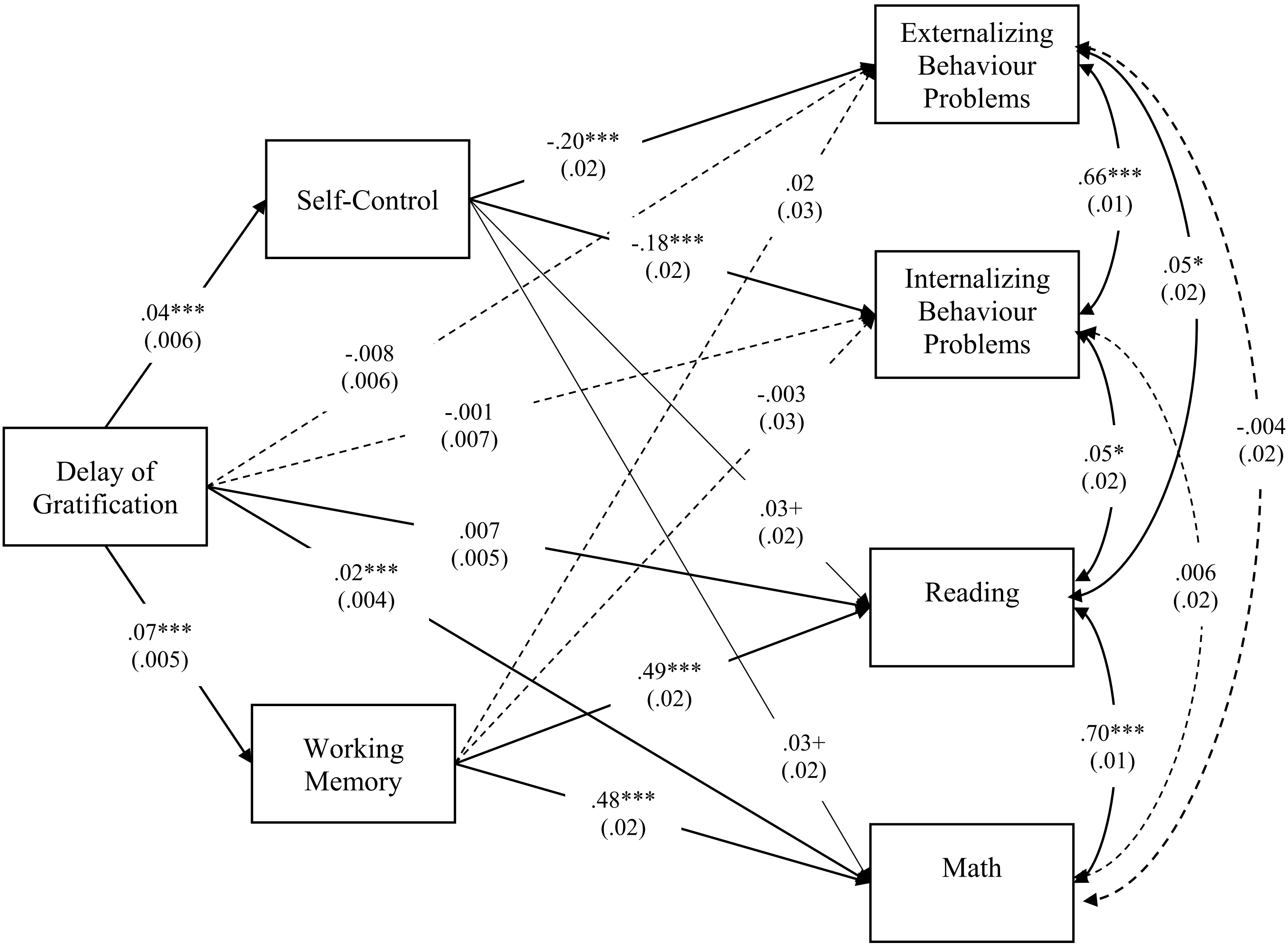

Figure 6. The Predictive Power of Delay of Gratification to Academic Performance and Behaviour Problems via Self-Control and Cognitive Function.
Note. Age, race, gender (dummy coded as 1=girl, 0=boy), SES, primary language (dummy coded as 1=English, 0=Non-English) were covariates.

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