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Only Child, Parental Educational Expectation, Self-Expectation and Science Literacy in Zhuang Adolescents in China: A Serial Mediation Model

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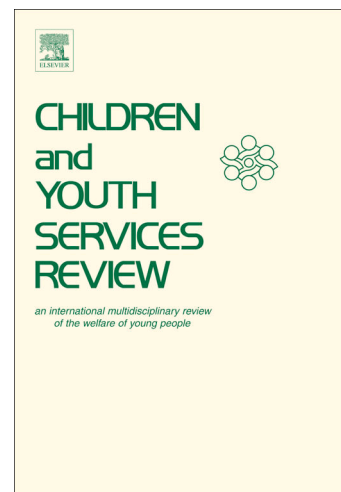
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Only Child, Parental Educational Expectation, Self-Expectation and Science Literacy in Zhuang

Adolescents in China: A Serial Mediation Model

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Authors' Note

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Only Child, Parental Educational Expectation, Self-Expectation and Science Literacy
in Zhuang Adolescents in China: A Serial Mediation Model

Abstract

The impact of only-child policy on Chinese children's development has been widely studied, leaving those from ethnic minority groups unexplored. This study investigated the possible mediating factors in the relationship between Singleton (only-child or not) status and science literacy in Zhuang adolescents, the largest ethnic minority group in China. Altogether 527 Zhuang students (Female = 263; aged from 13-17) were surveyed and tested with PISA Science (2008). The path and mediation analysis have confirmed that Parental Educational Expectation (PEE) and Self-Educational Expectation (SEE) acted as the serial mediators between Singleton and Science Literacy. This model indicates that Singleton causes a higher PEE, which is associated with a higher SEE, and eventually results in a higher Science Literacy. This finding implies that the Expectancy Value Model might be cross-cultural and universal, and highlight the importance of fostering a positive educational expectation to promote science literacy in adolescents.

Keywords: only child; scientific literacy; parents' educational expectation; self-education expectation

Only Child, Parental Educational Expectation, Self-Expectation and Science Literacy in Zhuang Adolescents in China: A Serial Mediation Model

The only-child policy in China is very rare and unique thus its impact on child development has been widely explored and debated (Deutsch, 2006; Falbo & Poston, 1993; Jiao, Ji, & Jing, 1996). Chinese parents were found to have significantly higher expectation on their only children than those with siblings, and accordingly, their only children were found to have better academic achievement than others (Li, 2007; Chen & Liu, 2014). However, the mechanism underlying this only child superiority (Deutsch, 2006) has not been thoroughly explored, thus the question how singleton (only child or not) and parental educational expectations could impact on the academic achievement has not been unaddressed. Besides, most of the existing studies focused on the students of majority Han group in China, leaving those ethnic minority adolescents under-studied. To fill these gaps, this study will, for the first time, explore the singleton status and its impact on science literacy in the ethnic minority Zhuang adolescents with a large-scale survey.

The Only-Child Policy and Its Impact on Child Development

In the late 1970s, the central government of China realized that the country could no longer afford the two-child family, as the long-term projection indicated that its population would climb to 1.3 billion by the year 2000 (Deutsch, 2006). In 1982, for instance, the national census recorded a population of 1.01 billion, amounting to 22.4% of the world's population (Falbo & Poston, 1993). In view of the threat of

population explosion, the central government initiated a new campaign in the early 1980s to strongly implement the world's most radical population policy: all married couples were to be restricted to one child, whereas those from the officially recognized 55 ethnic minority groups could have two (Deutsch, 2006). In the early 1990s, accordingly, about 98% of urban children (ages 3 - 6) were from one-child families (Jiao, Ji & Jing, 1996). In 2016, the one-child policy was abandoned, and since then, all the Chinese families could have two children (Li, Yang, & Chen, 2016).

In the past decades, the impact of only-child policy on child, family, and societal development has been widely explored. The policy has drastically transformed the Chinese family structure into the '4: 2: 1' one: four grandparents, two parents, and one child (the 'little emperor'). Parents have become more child-centered and spent more time and resources on childcare than those with multiple children; therefore, these 'little emperors' received more toys and lucky money and were more likely to have a bank account (Chow & Zhao, 1996). In addition, many parents wanted to compensate for the missing of siblings, which is the only-child's disadvantage, and thus would try their best to provide more educational resources (Li, 2007; Pöyliö, Erola, & Kilpi-Jakonen, 2017). Most parental purchases are directed toward their children's educational needs, such as toys, extracurricular activities, learning materials, and so on (Li, 2007). And their healthy development has become one of the most popular topics of discussion among scholars and parents in China: are they intellectually better than those with siblings? What are the cognitive and

socioemotional characteristics of these only-children?

Accordingly, many studies have explored the impact of this policy on a child's long-term development. Falbo and Poston (1993) sampled 1,000 students from 4 Chinese provinces to compare the developmental outcomes of only children against those with siblings (aged between 8 to 17 years, 50% Grade 3 and 50% Grade 6). The results indicated that only children outperformed others in verbal tests. Later, Jiao, Ji, and Jing (1996) found that in Grade One, the only children significantly outperformed those with siblings in cognitive abilities involving memory processes, language skills, and mathematics. But in Grade Five, the cognitive superiority of only children has decreased, reflecting the cohort differences between those only children. In 2006, Deutsch found that only children were more responsible for their parents' happiness than those with siblings. Besides, they were found to have a higher level of self-educational expectation and better academic performance than their peers with siblings (Chen & Liu, 2014).

All these studies, however, were conducted with the majority ethnic Han children (Chinese) in China. None of them has explored the only-children from the 55 ethnic minority groups. This is because the Chinese minorities have been allowed to have two children or even more in rural areas; thus, the number of ethnic minority only-child family was negligibly small. This study will be the first one to investigate the long-term effects of only-children policy on the ethnic minority-- Zhuang students' academic achievement.

Educational Expectations and Academic Achievement

Educational expectation refers to the anticipation of attainment at school/university including a short-term expectation for unit grades as well as a long-term expectation for the final educational attainment (i.e., high school or university graduation) (Pinquart & Ebeling, 2019). Educational expectation could be either parental educational expectation (PEE) or self-educational expectation (SEE). PEE refers to parental expectation for their children's educational attainment (Jaiswal & Choudhuri, 2017), and SEE means child's self-expectation on their own academic performance and achievement. In a recent meta-analysis, Pinquart and Ebeling (2019) found a significant cause-effect relationship between parental expectation and child achievement that persisted after controlling for socioeconomic status. And the associations varied by children's age, socioeconomic status, ethnicity, matching of type of expectations and achievement, type of expectation assessed, publication status, and informant. They found that SEE, academic engagement, academic self-concept, parental achievement-supportive behaviors mediated part of the effect of parental expectations on academic achievement, and the mediating effect of SEE was stronger in older children. These findings indicated that the impact could be moderated or mediated by age, SES, and ethnicity.

PEE and SEE might have special cultural appropriateness in Chinese society, which features the culture of "expecting children to have a bright future (望子成龙)". Most Chinese parents (if not all of them) tend to expect their children to get better education, better academic achievement, and accordingly better future. Some demanding parents are even strict disciplinarian with high expectation, thus are

labelled as ‘tiger mum’ by Chua in her controversial monograph -- *Battle Hymn of the Tiger Mother* (Chua, 2011). Furthermore, the long-run only-child policy has made Chinese parents put all hope in one child. As the only hope for the family’s future, the only child has thus received a higher level of PEE, resulting in a more intense parental supervision and higher parental expectation for better academic outcomes (Li, 2007).

In the Chinese context, PEE and SEE have proved to be a significant predictor of science achievement (Liu et al., 2006) and significantly correlated with their academic performance in middle schools (Wang, Xin & Li, 1999; Qian, 2008; Ning & Zhang, 2010). PEE has been found to have a consistent and significant effect on children’s reading, math, general knowledge, and science test scores (Wu & Qi, 2006). SEE has also been found as a significant contributor to science achievement (Areepattamannil, Freeman & Klinger, 2011). In addition, there was an interaction between the PEE and SEE. The Expectancy Value Model has been widely used to explain why parental expectation could predict child’s self-expectation and performance (Tiedemann, 2000; Smith, Brooks-Gunn, Kohen, & McCarton, 2001; Ardelt & Eccles, 2001; Fredricks & Eccles, 2002; Bleeker, & Jacobs, 2004). For instance, Eccle (1993) found that parental beliefs could influence parental behaviors, thus paving a way to influence youth motivational believe, which further contributes to youth behavior. A Chinese study has also proved that the higher parents' expectation for their children's education and career, the higher child-self expectation for their own education and future career (Cai, Wang, & Yang, 2007). All these results jointly indicated that PEE has a positive effect on SEE, which will be tested with Zhuang adolescents in this study.

Furthermore, in this study, we hypothesized that the PEE and SEE might jointly mediate between the singleton status and science literacy and tested this hypothesis with a large sample of Zhuang adolescents.

The Context of this Study

In China, officially, there are 55 ethnic minority groups in addition to the majority Han group. Zhuang, is the largest one of these minorities, with 18 million members mostly living in the Guangxi Zhuang Autonomous Region in southern China. Zhuang people have their own spoken languages that belong to the Thai branch of Zhuang-Dong Austronesian, but most of them speak Mandarin Chinese. In 1957, the Chinese government developed a writing system (using Latin alphabets) to record their spoken language. In 1982, the Zhuang language was revised and widely used to promote mother tongue language education. As the largest minority group in the country, Zhuang people have always been allowed to have two children per family. Therefore, the sample size of only children in Zhuang group was too small to study.

Recently, a meta-analysis (Pinquart & Ebeling, 2019) found that children's educational expectations, academic engagement, and academic self-concept, as well as parental achievement-supportive behavior, mediated the impact of parental expectations on child academic achievement. The results indicated that the transmission of positive PEE and the promotion of a positive SEE seem to be more promising than parental attempts to influence the academic achievement of their children directly. However, the mediation effect of SEE tended to be stronger with

families of older children, where parental expectations were more effectively transmitted, and SEE demonstrated more robust associations with achievement. All these findings indicated that PEE and SEE might jointly mediate the impact of Singleton on students' especially those adolescents' academic achievement. Therefore, we proposed a serial mediation model (see Figure 1) to explain the joint mediating roles of PEE and SEE in this study. In particular, the following questions guided this research:

1. Will only children have better science achievement than their peers with siblings?
2. Does PEE play a mediating role between singleton and science literacy?
3. Does SEE play a mediating role between singleton and science literacy?
4. Will PEE and SEE jointly play the serial mediating roles in the relationship of the singleton and science literacy?

Accordingly, we proposed the following four hypotheses for this study:

H1: The only children have higher science literacy than their peers who have siblings;

H2: PEE plays a mediating role between the only children and science literacy;

H3: SEE also plays a mediating role between the only children and science literacy;

H4: PEE and SEE play the serial mediating roles in the relationship between the only children and their science literacy.

Insert Figure 1 about here

Methods

Participants

This study was part of a research project on junior secondary students' quality initiated and funded by the educational authorities of a rural area in Y province. This rural area is located in southwestern China and consists of four districts and two counties. It has 106 junior secondary schools altogether, and 102 of them are located in rural areas. The first author got the contract through a conventional bidding system and was authorized by the Department of Education to conduct this project in the 106 schools during 2018. One Grade 9 class was randomly sampled from each participating school, resulting in 106 participating classes. All the students from the participating Grade 9 classes were invited to participate in this contract research project. Only the Zhuang students who had completed all the surveys and tests were included in this study. All the students of other ethnic groups (including the Han group) were excluded from this study. In total, 527 students ($N_{Female} = 263$) in grades 9 ($Mean_{Age} = 14.88$, range = 13–17, $SD = .933$) participated in the study, involving 51 middle schools in the county. The monthly parental income in the non-one-child group was about 3,000 RMB, and the one-child group was about 4,000 RMB. The parental degrees of both the only child and the non-only child groups were mostly junior high school graduates. The per capita annual disposable income was 33,488

RMB per person in 2018, which is higher than the national average level (28, 228 RMB per person).

Measures

Singleton status. All the only children were identified by the participant's response to the question -- "are you the only child in your family?". 1 = *no*, 2 = *yes*. There were 61 only-children (11.6%, $N_{Female} = 20$) and 466 non-only children (88.4%, $N_{Female} = 243$) in this study.

Parents' educational expectation (PEE). PEE was measured by the participant's response to the questions -- "which level of educational degree do your parents expect you to obtain?" They could choose the answers ranged from 1 = *graduate from middle school* to 8 = *doctoral degree*.

Self-education expectation (SEE). SEE was measured by the participant's response to the question "which level of educational degree do you expect yourself to obtain?" They could choose the answers ranged from 1 = *graduate from middle school* to 8 = *doctoral degree*.

Scientific Literacy (SL). Scientific literacy, as defined by the Program for International Student Assessment (PISA), is "the ability to understand nature, make comments, and draw inferences about it (nature), be able to identify scientific problems using scientific concepts, be able to use scientific process skills to solve them, and be able to willingly engage with ideas and professions related to science" (OECD, 2019). The aim of the PISA Science Literacy test is to research and determine the extent to which students have mastered these skills in daily life rather

than determine whether they have acquired scientific knowledge. In addition, the PISA science literacy scale is also used to assess the extent to which students have mastered certain identified critical thinking skills (OECD, 2017). In this study, SL was assessed using the publicly released Chinese version of PISA Science (2008) test. This Chinese version was first applied to the 15 year-olds in Shanghai in 2009 (Sellar & Lingard, 2013), and later on, released online for public use (http://pisa.nutn.edu.tw/sample_tw.htm). It measures basic skills such as being able to explain phenomena scientifically, evaluate and design scientific enquiry, and interpret data and evidence accurately. In total, it has five parts: 1 = *the ability to identify scientific problems*; 2 = *the ability to explain scientific phenomena*; 3 = *the ability to interpret scientific data and evidence*; 4 = *scientific essential knowledge accomplishment*; 5 = *scientific knowledge accomplishment*. The total score of students' scientific literacy (500 ± 100) was calculated by using the Item Response Theory model according to the difficulty parameters disclosed by PISA, and the total score for each student was converted to a standardized score (z score) in the statistical analysis in this study.

Procedures

Ethical procedures were followed throughout the study. First, the first author's University and the Department of Education of the research site approved the study in advance of data collection. Before data collection, consent was obtained from the educational directors and the principals of the participating schools. Students were briefed about the survey by a trained graduate researcher and consented to participate

in this study. The students from the same class were assembled in the same room where they completed the paper survey. The PISA test was conducted by the participating schools as a term exam.

Data Analysis

First, a set of ANOVAs was conducted to examine the effect of Singleton on PEE, SEE, and Science Literacy. Second, Pearson correlation analyses were conducted to investigate the associations among all the study variables. Third, based on the correlations of the variables, a bootstrapping analysis using IBM SPSS Statistics version 23.0 and macro-program PROCESS 2.1 (Hayes, 2013) was conducted to test the hypothesized mediation models. The bias-corrected bootstrap method with 5,000 resamples was employed to calculate the 95% confidence intervals (CI).

Results

Descriptive Statistics

Findings from ANOVAs revealed a significant main effect of singleton in Parental Education Expectation [$F(1, 525) = 5.541, p < .05, \eta^2 = .248$], Self-Educational Expectation [$F(1, 525) = 12.406, p < .001, \eta^2 = .670$], and Science Literacy [$F(1, 525) = 6.859, p < .01, \eta^2 = .082$]. Table 1 presents the descriptive statistics for the study variables.

Insert Table 1 about here

Intercorrelations among the studied variables for the total sample, only-children, and children with siblings are presented in Table 2. In the total sample, Singleton was significantly and positively correlated with Science Literacy ($r = .114, p < .01$), PEE ($r = .102, p < .05$), and SEE ($r = .152, p < .01$). PEE was significantly and positively related to SA ($r = .186, p < .001$). SEE highly correlated with PEE ($r = .502, p < .001$) and Science Literacy ($r = .214, p < .001$). The same pattern of results was found in the children with sibling group; the only-child group, however, did not see a significant correlation between PEE, SEE, and Science Literacy. The following analyses of hypothesized models were conducted based on the correlation matrix of the variables.

Insert Table 2 about here

Mediation Model with Singleton and Science Literacy

The previous analyses revealed that the singleton status (only-child vs child with siblings), PEE, and SEE were correlated with Science Literacy, and there were positive correlations among them. First, we conducted the regression analyses before testing the mediation model to explore the paths between the study variables. All these correlated variables were included in the regression analyses. As shown in Table 3, the results of the total sample confirmed that: (1) Singleton status was a positive predictor of Science Literacy ($\beta = .130, p < .01$); (2) Singleton also contributed to

PEE ($\beta = .094, p < .05$) and SEE ($\beta = .105, p < .01$), respectively; (3) PEE also positively predicted SEE ($\beta = .474, p < .001$) and Science Literacy ($\beta = .107, p < .05$), respectively; and (4) SEE also significantly predicted Science Literacy ($\beta = .143, p < .01$).

Insert Table 3 about here

Next, mediation analysis using the Bootstrap (model 6, sampling 5000 time) method was conducted to examine the direct and indirect effects of PEE and SEE on SL, of which the results were all significant (95% CI did not include 0). As shown in Table 4, the results indicated that in the full model: (1) Singleton had a significant direct influence on SL ($\beta = .2819$, 95% CI ranged from .0219 to .5418); (2) the indirect effect of Singleton \rightarrow PEE \rightarrow SEE \rightarrow SL was ($\beta = .0491$, 95% CI ranged from .0108 to .1206); (3) the indirect effect of Singleton \rightarrow PEE \rightarrow SL was significant ($\beta = .0347$, 95% CI ranged from .0005 to .1023); and (4) the indirect effect of Singleton \rightarrow SEE \rightarrow SL was also significant ($\beta = .0236$, 95% CI ranged from .0047 to .0588). No significant results were found in other paths and other indirect effects. All these findings jointly support the serial mediation model for the total sample, which means that Singleton indirectly impacted on SL through PEE and SEE, respectively. This finding indicated that the only-child status might not only directly

affected SL, but also indirectly affected SL by influencing both PEE and SEE. Final models for the whole sample were shown in Figure 2.

Insert Table 4 & Figure 2 about here

Discussion

The primary objective of this study was to understand how the only-child status impacted on science literacy via the serial mediation of parental education expectation (PEE) and self-education expectation (SEE) in Zhuang adolescents in China. In particular, we were fascinated in understanding how the Singleton changed PEE and accordingly SEE, and facilitated science literacy in this unique ethnic minority group. The results indicated a serial mediation of PEE and SEE between Singleton and Science Literacy for the whole sample. This section will discuss the major findings and their implications for policy development.

The Impact of Only Child Policy on Zhuang Adolescents' Science Literacy

This study found that the only child in Zhuang group had significantly better science literacy, which is consistent with other studies on the majority Han students in China and those in other countries (Falbo, 1986). Besides, the parents of only child tended to have a higher educational expectation (PEE) and accordingly, the students tended to have higher self-education expectation (SEE). The interaction between high PEE and high SEE has resulted in higher science literacy. And previous studies have

also reported similar findings (Chen & Liu, 2014; Li, C., 2007; Li, L., 2007). So, what are the mechanisms underlying the impact of Singleton on Zhuang adolescents' science literacy?

The first interpretation might be the compensatory mechanism. Like those Chinese parents of only-child, the Zhuang parents would try their best to provide their only-child with a better environment and better education to compensate for the missing of siblings (Li, 2007). In addition, according to the resource dilution hypothesis (Becker & Lewis, 1973), the smaller the family size, the higher monetary and non-monetary investment in education resources for children. In this study, the Zhuang parents could use all the family resources for the only child, who would be in a better situation than those with siblings to share the resource. Accordingly, the only-child tended to have more educational opportunities and resources than those non-only children (Li, 2007). Consequently, the only-child would have better academic achievement than those with siblings.

The second possible mechanism might be the Pygmalion effect (Rosenthal, 1974), which means that others' expectations of a target person will affect his/her performance. The Zhuang parents tend to have higher expectation on the only child as they are the only hope and the only outlet of all family hope. If the only child fails, the whole family fails. This is very similar to those Chinese parents of the only child who have a traditional culture of “expecting children to have a bright future (望子成龙)” (Leung & Shek, 2011). Accordingly, the only child would have higher parental education expectations, compared with the non-only child. And parental expectations,

the willing of making up for parents' dedication, have also affected their only child, leading them to set higher self-education expectation (Kim & Park, 2006). This Pygmalion effect has been supported by the findings of this study. For example, the parents of only-child tended to have higher PEE and would invest more time and energy to help their child to excel in academic performance. Jointly and eventually, the two mechanisms have made only child perform better in science literacy than those with siblings.

The Serial Mediation Model of PEE and SEE

This study found that parental educational expectation and self-education expectation jointly mediated the relation between singleton and science literacy. The only child in ethnic Zhuang group tended to have a higher parental educational expectation and then higher self-education expectation, and eventually better science literacy. So, one may ask why and how the serial mediation of PEE and SEE could have worked in the path from Singleton to science literacy.

Parental expectations are mental states that cannot directly influence academic achievement; instead, some variables mediate the effects of PEE (Pinquart & Ebeling, 2019). Seginer (1983) proposed SEE as the mediator of the impact of PEE on child's academic achievement: communicated parental expectations might affect child's self-expectation, which would eventually affect child's academic motivation and then achievement. Later, Eccles (1993) proposed the Expectancy Value Model to depict this cascade process: first, PEE triggers parental behavior geared toward promoting children's engagement; second, the engagement promotes student's self-concept and

self-expectation (SEE); last, it affects child behavior and achievement. This Expectancy Value Model has been empirically supported by the findings of a recent meta-analysis (Pinguat & Ebeling, 2019). All the studies in this meta-analysis, however, are from non-Chinese contexts and with non-only children. This study, for the first time, has confirmed that the Expectancy Value Model also applies to the Zhuang adolescents in China, indicating its cross-cultural and universal appropriateness. In addition, this study has verified that PEE and SEE could jointly promote Zhuang adolescents' science literacy, which is consistent to the findings of previous studies (Areepattamannil, Freeman, & Klinger, 2011; Britner & Pajare, 2006; Liu et al., 2006; Uçar, & Sungur, 2017). This finding indicates that the serial mediation of PEE and SEE might also apply to science and even other subjects, which really deserves further studies.

Conclusions, Limitations, and Implications

As the first empirical exploration of the effects of Singleton on science literacy in Zhuang adolescents in China, this study has very preliminary but noticeable findings. First, the only children were found to have higher parental and self- educational expectation and science literacy than their peers who have siblings. Second, PEE played a mediating role between the only children and their science literacy. Third, SEE played a mediating role between the only children and their science literacy. Fourth, PEE and SEE played the serial mediating roles in the path from Singleton to science literacy.

This study, however, has some limitations. First, it was a retrospective research

that might not be able to solidly confirm the cause-effect relationships between Singleton and children's science literacy. Longitudinal or experimental studies should be conducted in the future to verify these findings. Second, the parental educational expectation was reported by the adolescents using a single-item scale, which might have a bias. Further studies should include both maternal and paternal reports using more items, which can be used to verify or cross-check the reported answers. This will enhance our understanding of the distinct parental roles with regard to children's self-education expectation and can help us to determine whether maternal and paternal expectation is related to children's science literacy. Third, PEE and SEE had a small mediating effect on SL in this study, indicating that there might be some other variables (i.e., parental behaviors, youth behaviors) mediating or moderating the path. Further studies are needed to explore all the confounding and mediating factors. Last but not least, this study did not consider the influence of family SES on children's science literacy. It would be perfect if future studies could explore the associations between family SES and children's self-education expectation in these Zhuang adolescents.

Nevertheless, this study found that only child had a better science literacy through the serial mediation of parental educational expectation and self-education expectation in Zhuang adolescents in China. This result implies that the Pygmalion effect and the associated Expectation Theory Model also apply to Zhuang adolescents. This finding yields important implications for parent education matters. First, the finding that parental educational expectation and self-education expectation are

significant mediators implies that an appropriate level of expectation may benefit children's learning. Thus, it is valuable to guide parents and children to set reasonable and feasible educational expectations, too high or too low expectations might hurt academic performance. Second, parents should be recommended to have an equally high educational expectation for their children, no matter only child or not. It is especially necessary to encourage those parents of a child with siblings to express their expectation, strategically and skillfully. This will help to maximize the positive effects of PEE on their child's academic development. Third, parents should learn to discuss a study plan with their children and make sure that PEE can match with SEE and can jointly improve their academic performance. The finding of this study implies that longitudinally, PEE and SEE might be more effective in realizing parental expectations than simply involvement with daily learning activities.

Last but not least, the finding that only-child has better science literacy might have implications for policymaking. It indicates that the only-child policy might have some benefits to child development. Coincidentally, Deutsch (2006) also found that the only-child policy had promoted gender equality in urban China, even though it might have restricted reproductive rights. This only child superiority, however, should not be taken as an endorsement of the one-child policy. Instead, it does imply that we need to take a careful look at how any family policies can have unintended consequences for children, whether for good or for ill.

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Table 1

Participant Characteristics

	Total	Only child	Non-only child	F(1, 525)	η^2
Sample	527	61	466		
		(11.6%)	(88.4%)		
Age	13-17	15.27	14.85		
		(1.032)	(0.922)		
Parents' educational expectation	3.65	4.18	3.58	5.541*	0.248
	(1.890)	(2.004)	(1.865)		
Self-education expectation	3.78	4.66(2.190)	3.67	12.046***	0.670
	(2.088)	()	(2.049)		
Science Literacy (Z score)	-0.064	0.243	-0.105	6.859**	0.082
	(0.979)	(0.949)	(0.977)		

Table 2

Pearson Correlations among Study Variables

	1	2	3	4
<i>Total Sample (N = 527)</i>				
1. Only child	1			
2. Parents' educational expectation	0.102*	1		
3. Self-education expectation	0.152**	0.502**	1	
4. Science Literacy	0.114**	0.186**	0.214**	1
<i>Only child (N_{only child} = 61)</i>				
1. Parents' educational expectation	1			
2. Self-education expectation	0.550**	1		
3. Science Literacy	0.071	0.215	1	
<i>Non-only child (N_{Non-only child} = 466)</i>				
1. Parents' educational expectation	1			
2. Self-education expectation	0.487**	1		
3. Science Literacy	0.190**	0.198**	1	

Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 3

Path Analysis Results

	Total Sample (N = 527)
Only child on Science Literacy	0.130**
Only child on Parents' educational expectation	0.094*
Parents' educational expectation on Self-education expectation	0.474***
Parents' educational expectation on Science Literacy	0.107*
Self-education expectation on Science Literacy	0.143**
Only child on Self-education expectation	0.105**

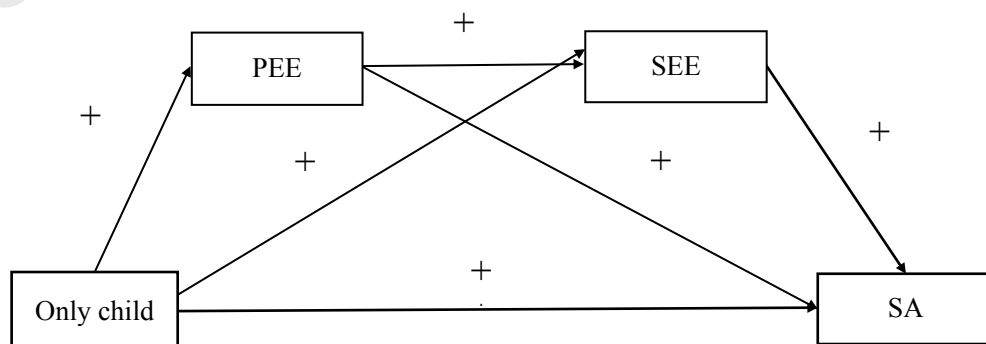
Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 4

Direct and Indirect Effects of Only child on scientific Achievement

Paths	Full	
	Effect	95% CI
Only child → Science Literacy	0.1074	[0.0406, 0.1967]
Only child → Parents' educational expectation → Science Literacy	0.0347	[0.0005, 0.1023]
Only child → Self-education expectation → Science Literacy	0.0236	[0.0047, 0.0588]
Only child → Parents' educational expectation → Self-education expectation → Science Literacy	0.0491	[0.0108, 0.1206]

Note. PISA raw score was transformed into z score to indicate Science Literacy.



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Figure 1. Serial Mediation Model Hypothesized for This Study.

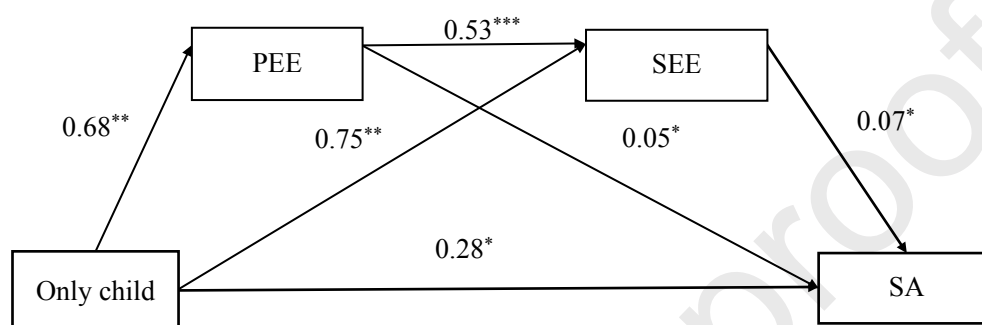


Figure 2. Associations between Only Child and Scientific Achievement for the Whole

Sample ($N_{\text{total}} = 527$). Serial Mediation Analysis: Parental Educational Expectation and Self-education Expectation as serial mediators.

Only children had significantly higher parents' educational expectation (PEE), self-education expectation (SEE), and science literacy than those with siblings;

PEE had a positive impact on SEE, which also had a positive effect in science literacy;

PEE and SEE were identified as the serial mediators between Singleton and science literacy in the best-fit model. These findings imply that the Expectancy Value Model might be cross-cultural and universal, and highlight the importance of fostering a positive educational expectation to promote science literacy in adolescents.