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Boosting Early Development: The Mixed Effects of Kindergarten Enrollment Age

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This study aimed to investigate the effects of kindergarten enrollment age on four-year-old Chinese children's early cognition and problem behavior using multilevel models. The sample comprised of 1,391 pre-school children (the mean age is 4.58 years old) from 74 kindergartens in six different provinces. The results demonstrated curvilinear effects of kindergarten enrollment age on children's cognitive and behavioral performances. What parents do also matters: HLE (home learning environment) moderated the effects of enrollment age. For low HLE children, early enrollment resulted in higher cognitive performance but more behavioral problems; for children with higher HLE, moderate enrollment age was the most beneficial. The results were discussed in light of pre-school policy and practice.

Keywords: pre-school education, kindergarten enrollment age, early cognition, problem behavior, HLE (home learning environment)

Introduction

The importance of a successful pre-school education can never be overstated. An influential scientific finding (Shonkoff & Phillips, 2000) lends strong support to the role of early learning which lays the foundation for the life-long development of individuals; specifically, the early acquirement of cognitive and socio-emotional capacities make later learning activities more effective. Countries around the world have gradually realized the importance of pre-school, and thus, early childhood education and care have received much attention. China with nearly one fifth of the world population is also trying to promote easier access to kindergarten education. While China is now working on the universalization of kindergarten education, the question of how enrollment age influences children's cognitive and socio-emotional development remains unanswered.

Chinese Kindergarten

As a major type of pre-school in China, kindergarten education consists of the basis of compulsory education, and is regarded as an essential part in promoting individual development, in enforcing and raising the quality of education as well as in achieving education equality (Xia & Zhang, 2010). After China has achieved free compulsory education of all the school-age children in 2006, providing easy access to universal pre-school education has become the core objective in educational development for many provinces and cities (Xia & Zhang, 2010). There have been numerous calls for expanding public support of kindergarten to equalize

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access to quality early education opportunities.

Kindergartens in China and pre-schools in Western countries differ in many aspects. As to the matter of enrollment age, different cultures have different regulations and traditions. It should be noted at first that "pre-school" in America refers to pre-kindergarten child care, while in China, the same word refers to kindergarten education. In the American system, kindergarten constitutes the beginning of formal education and usually starts when children turn five years old and lasts for one year before they enter primary school; pre-kindergarten institutions may include various special programs like head start or day-care centers, and pre-school education is optional and more often than not serves as the last resort when maternal care is inaccessible. In contrast, most Chinese mothers work outside either to support the family or ensure economic independence of them. And, thus, young children's enrollment in kindergarten is inevitable if grandparents' care is unavailable considering the high cost of private babysitting. Besides, it has long been a tradition that Chinese children attend kindergarten to be prepared both intellectually and emotionally for formal education. China is now trying to provide more access to three years' kindergarten education before primary school to meet the ever increasing demand. By now, kindergarten has not been included in compulsory education and it largely depends on Chinese parents themselves when sending children to kindergarten or not and, thus, children's enrollment ages vary considerably. Consequently, it naturally gives rise to the question that when entering kindergarten could improve children's cognitive and behavioral development the most effectively.

In addition, the pattern of pre-school also varies a lot between China and America. American states vary in their pre-school rules and regulations and there are a variety of pre-school programs. In contrast, China has a national pre-school standard and a national curriculum (Tobin, Wu, & Davidson, 1989). Therefore, Chinese kindergartens may be more homogeneous in contrast with the diversity in American pre-schools, which makes the results of certain kindergarten studies more generalizable in China.

Effects of Kindergarten Education on Early Cognition and Academic Achievement

Empirical evidence of effects of kindergarten on school readiness in Chinese context is quite limited. Since kindergartens in China and pre-schools in western countries differ in many aspects, one could not be too cautious when applying research results obtained from western countries to Chinese context. However, it is still necessary and helpful to review previous studies on the effects of kindergarten in other countries, given the common characteristics of early childhood development.

The study on the effectiveness of pre-school education was firstly focused on children at risk, and later, researchers began to explore the effect of pre-school on the whole population (Sylva, Melhuish, Sammons, Siraj-Blatchford, Taggart, & Elliot, 2003). Researchers have found a long-term positive effect of pre-school on academic improvement (Berlinski, Galiani, & Gertler, 2006), and there is even significant influence on academic achievements in junior high school (Melhuish et al., 2009). Since a large body of researches has evinced the positive influence of kindergarten attendance on early cognitive development as well as academic achievements, researchers began to specify the effects of various dimensions of kindergarten education setting, and this paper focuses on the effects of enrollment age on which researchers have not yet reached a consensus.

On the one hand, some evidence suggests that it is the older children that could benefit more from kindergarten education (Bickel, Zigmond, & Strayhorn, 1991; DiPasquale, Moule, & Flewelling, 1980;

Robinson, 1986; Warder, 1999). To elaborate this point, it is necessary to turn to the focus of kindergarten education at first. The focus of kindergarten, at one time, was to provide opportunities for children to learn how to socialize and play with peers through activities that prepare young children for future social life. However, nowadays, the emphasis of kindergarten has been modified to provide children with pre-academic skills that are perceived as essential preparation for academic competition. As a result, kindergarten education has the added responsibility of preparing students for the later education (Lin, Freeman, & Chu, 2009), the case in China is similar in this sense. While children in kindergarten are burdened with more pre-academic training, it is plausible to explain the reason why young children could not be as benefited academically as their elder classmates in kindergarten (Bickel et al., 1991; DiPasquale et al., 1980; Robinson, 1986; Warder, 1999). Possible explanations are that elder children are more mature both physically and psychologically, therefore, kindergarten could effectively help improve their cognitive development; in contrast, younger children could not reap the benefits of kindergarten education (Warder, 1999).

On the other hand, many people are enthusiastic about the so-called “early start”. They hold that the earlier infants are put into a stimulating environment, the better their intelligence is developed. Some Chinese parents also prefer an early enrollment in kindergarten, for they hold that an early intelligent development would advantage later academic performances. In 1995, American researcher, Reynolds (1995) investigated black children participating in head start, and found that those who participated in the program before two years old had an advantage in academic achievement over those who were enrolled at the age of four. A large-scale survey in Britain presented similar results: the EPPE (Effective Provision of Pre-school Education) project (Sylva et al., 2003) investigated a national representative sample and revealed that the earlier the pre-school started, the better the cognition and socialization of children were. Sammons, Elliot, and Sylva (2004) further analyzed the EPPE data and found that children with more than three years’ kindergarten experience performed significantly better in tests.

So far, it turns out that the effect of kindergarten becomes quite complicated after taking the enrollment age into consideration and researchers have not reached a consensus on this very issue yet. Some researchers tried to solve the debate by suggesting an optimal enrollment age instead of “the earlier the better” or “the later the better”. Caughy, DiPietro, and Strobino (1994) studied the impact of day-care during infancy on math and reading scores of five- and six- year-old. They found that day-care participants at three years old instead of younger ages performed better than those without day-care. The results of Loeb, Bridges, Bassok, Fuller, and Rumberger (2007) took a further step: by analyzing the data of EPPE via three methods of regression, instrumental variable and propensity score, respectively, consistent results were obtained suggesting that children entering pre-school centers at the ages of two or three years (rather than younger or older ages) were most beneficial in terms of cognitive performances.

While the results from researches conducted in Western contexts may not well apply to the Chinese situation, considering both the pros and cons of kindergarten education, we expected a curvilinear effect of enrollment age in this study.

Effects of Kindergarten Education on Scio-emotional Development

The majority of the aforementioned literature focused on children’s early cognition (Caughy et al., 1994; Melhuish et al., 2009). A closer look at the effect of kindergarten may bring up questions about the effect of kindergarten education on socio-emotional or behavioral development, considering that kindergarten education

has been mainly focused on pre-academic skills other than socialization (Entwisle, Alexander, Cadigan, & Pallas, 1987). Fewer studies dealt with the influence on non-cognitive development.

Before enrollment age was taken into consideration, researchers firstly explore the effects of kindergarten attendance, and evidence on both sides exist: on the one hand, some evidence has supported that being placed in stimulating learning environment in early childhood plays an irreplaceable role in children's cognitive as well as non-cognitive development (Sylva et al., 2003); on the other hand, it was found that early separation from parents may produce more problem behaviors in young children (Magnuson, Ruhm, & Waldfogel, 2004). When enrollment age was considered, more inconsistent results were reported. Connell and Prinz (2002) investigated the impact of care center attendance on social skills of low-income African American children, and found that children who entered care center at younger ages were rated higher by teachers in social skills assessment, but children who stayed longer in care center per week were rated lower. However, some researches on common kindergartens or nurseries revealed that younger children were more likely to have problem behaviors (Loeb et al., 2007; Magnuson et al., 2004). It was also found that early and extensive non-maternal child care, particularly center-based care, was associated with higher levels of behavior problems in school (Early Child Care Research Network, 2003). It should be noted that each research covered only a considerably narrow range of enrollment age and children in a certain study were likely to come from a certain level (either low or high) of socio-economic status. Considering the aforementioned mixed evidence, it is reasonable to suggest that the relationship between enrollment age and behavioral development may not be a linear one if it does exist.

The Moderating Effect of Family Backgrounds

What other issues jointly contribute to better early development besides kindergarten education? It is said that parents are first teachers of children. Early learning and development rely heavily on family environment, both economically and culturally. Numerous researches have supported the great impact of family socio-economic status (indexed by maternal education or family income or both), but it is noteworthy that HLE (home learning environment) cannot be reduced to collection of books or diploma of parents. Some researchers have noticed that certain behaviors of parents could greatly influence children's learning and development (Lv, 2008; Melhuish et al., 2009), which constitute the concept of HLE in the current study. Some researchers (Christian, Morrison, & Bryant, 1998) developed a family culture environment scale to measure parents' behaviors which were found to promote children's early learning capacities. Chinese researcher Sun (2007) also found that behaviors, such as taking children to performances/sports games/movies, and explaining nature or scientific phenomena to children, had a positive impact on school readiness. In a longitudinal research (Chang, Park, & Kim, 2009) in which parents learnt to provide children with more education activities; after the intervention, it was found that children's language and cognitive development were greatly improved. In another case, HLE was still found significantly influencing children's early learning and development even when home SES (social economic status) and other background variables were controlled (Melhuish et al., 2009).

The moderating effects of background variables have long been an interesting topic. Since the studies of kindergarten effect were firstly focused on disadvantaged group, people may reasonably doubt whether children from well-off families could benefit from non-maternal pre-school as much as their poor peers. Indeed, some research evidence has shown that effects differ depending on children's family backgrounds and subsequent

schooling, with the largest and most lasting academic gains for disadvantaged children and those who later attend schools with low levels of academic instruction (Bradley, Corwyn, McAdoo, & Coll, 2001; Caughy et al., 1994; Christian et al., 1998; Entwisle et al., 1987). Recently however, some researchers (Melhuish et al., 2009) made a different voice by demonstrating the same positive impact of kindergarten attendance on poor and rich children.

It can be seen that most studies have involved home SES, but fewer considered the effect of HLE, which can be defined as certain parental behaviors that stimulate or promote children's learning activities. The study of Christian et al. (1998) differentiated the impact of maternal education level and HLE, finding that math achievements of four- and five- year-old children who had both lower maternal education level and lower HLE are associated with the length of day-care (in month); those with high maternal education level were not influenced by day-care length. And Christian et al. (1998) also suggested that the effect of day-care length was linear for disadvantaged children.

Research Aims

In short, the purpose of this study was to investigate the influence of kindergarten enrollment age on early cognitive and behavioral performances, two of the basic components of school readiness. When exploring cognitive and behavioral development at the same time, a full picture of the impact of kindergarten education could be obtained and the effect of kindergarten may turn out to be more complex. Our analysis started by asking the question: Is there a curvilinear relationship between kindergarten enrollment age and early cognitive and behavioral performances, or does there exist an optimal enrollment age? Furthermore, we explored the moderating role of HLE to cast some light to the effective combination of kindergarten and family education. Never before has the field been able to test these relationships with a nationally representative sample of young children with sufficient family background data. These issues are directly germane to the debates over whether extending free pre-school to all children is a cost-effective policy, whether starting at younger ages is advisable, and how family learning environment is interacted with kindergarten education.

Material and Methods

Participants

The present research is a part of the ELDG (Early Learning and Development Guidelines) project (2005-2010) in China. Two provinces were selected from the Eastern, Middle and Western part of China respectively, according to the classification of the Ministry of Education. Twelve regions from the six provinces were involved, strategically chosen to include urban, suburban and rural areas. In each region, individual kindergartens with different funding sources (government, corporation or individual) were randomly selected. A total of 72 kindergartens were selected in the study, which yielded a sample of 1,484 children already enrolled in kindergarten classrooms by then. At the time of testing, the average age of children was four years and six months, with a range of three years old to four years and eight months. After excluding subjects with main variables missing, the effective sample consisted of 1,391 children of roughly equal percentages of males (N = 677) and females (N = 714).

A statistical description of the distribution of enrollment age by group (high maternal education and low maternal education) is provided in Table 1. Some variables were missing for children whose parents or teacher omitted certain items. These children were retained in the analysis.

Table 1

Descriptive Statistics for Predictor Variables

	Total	Low maternal education level	High maternal education level	Maternal education unknown
Gender				
Male	677 (48.6%)	430	222	26
Female	714 (51.4%)	466	231	16
Age	53.93 (2.00)	54.04 (2.05)	53.66 (1.87)	54.50 (2.13)
Enrollment age				
< 2 years	107 (7.7%)	67	35	5
2 to 2.5 years	294 (21.1%)	165	128	1
2.5 to 3 years	214 (15.4%)	117	89	8
3 to 3.5 years	456 (32.7%	315	130	11
> 3.5 years	162 (11.6%)	129	24	9
Unknown	158 (11.5%)	103	47	8
Kindergarten level				
Unclassified	292 (21.1%)	227	55	10
Community-level	303 (21.8%)	240	51	12
City-level	333 (23.9%)	211	112	10
Province-level	463 (33.2%)	218	235	10
Family annual income				
< 12,000	288 (20.7%)	240	38	10
12,000 to 40,000	629 (45.3%)	440	174	15
> 40,000	389 (27.9%)	156	229	4
Unknown	85 (6.1%)	60	12	13
HLE				
< 1SD	198 (14.2%)	170	20	8
Medium	989 (71.2%)	634	326	29
> 1SD	204 (14.6%)	92	107	5
Guardian				
Two parents	1,137 (81.8%)	699	411	27
Single parent	92 (6.6%)	68	20	4
Grandparents	156 (11.2%)	127	22	7
Unknown	6 (0.4%)	2	0	4

Note. SD = standard deviation.

Measures

Cognitive skills. The children were assessed with a cognitive battery developed as the validation tool for ELDG project. The assessment consists of nine partial credit cognitive tasks and each item examines one aspect of cognitive skills (including comparing sizes, orientation, addition and subtraction, jigsaw, categorization, sorting, mode, measurement and extraction). For example, Table 2 presents the task of orientation with its materials, procedures, instructions and grading standards identified. The battery was administered to children by trained examiners on a one-to-one basis and each task was scored on a five-point scale.

The Cronbach's α between tasks was 0.70. The resulting score was calculated using IRT (Item Response Theory), which uses children's response patterns and the difficulty of items to place each child on a continuous ability scale. ConQuest2.0 (Wu, Adams, Wilson, & Haldane, 2007) was applied to estimate the latent ability level of each subject using partial credit model. The outcome was the transformation of latent ability scores into

standardized t-scores with a mean of 50 and standard deviation of 10.

Table 2

A Sample Item of Cognitive Measurement

Orientation Material	Procedure	Instruction	Grading standard
One black, one red and one yellow buttons; a toy dog	1. The experimenter sits beside the child, placing three buttons in a vertical line, and then asks the child to point out the farthest button from himself. (Mission terminated if the child fails) The experimenter puts the black and red buttons on the near side of the desk and puts the yellow one on the other side of the desk. The child is required to pick up the button which is right beside the black button. (Mission terminated if the child fails) 2. The experimenter places the toy dog facing the child; put three buttons in a vertical line before the dog. The child is required to pick up the two buttons nearest to or farthest from the dog. 3. The experimenter places two buttons: one on the right side and one on the left side of the child. The child is required to pick up exactly the left or right button when asked to do so. (Mission terminated if the child fails) The experiment places the toy dog facing the child. First ask the child to put a button on the left side of the dog, then ask the child to put one on the other side.	1. Look, here are three buttons. Which button is the farthest from us? Which button is the nearest to us? Please hand me the button beside the black button. 2. (Show the toy dog) Now I put buttons before the puppy, which button is the farthest from the puppy? Which button is the nearest to the puppy? 3. Please show me the button on your left side. Please show me the button on your right side. Please put this button on the left side of the puppy. Now please put this button on the right side of the puppy.	0. Fails to distinguish near and far self-centered or acquire the concept of beside. 1. Can distinguish near and far self-centered, and has required the concept of beside. 2. Can distinguish near and far other-centered. 3. Can distinguish right and left self-centered. 4. Can distinguish right and left other-centered.

Problem behaviors. Teacher reports of children's externalizing aggressive behaviors measured children's problem behaviors in classroom. Teachers rated each child in an eight-item behavioral assessment (e.g., He/She is disobedient, and will defy every order), according to the description's conformity with children's behaviors in kindergarten. The Cronbach's α among items was 0.63. The raw score of behavioral assessment underwent the same process as that of cognitive measurement. The latent trait was estimated and transformed to *t* score with a mean of 50 and standard deviation of 10.

HLE. HLE scale with 12 items was used to assess the frequency of learning-related parental behaviors. Frequency of activities was coded on a four-point scale (0 = Not at all; 4 = Very frequent). Total possible scores ranged from 12 to 48 with higher scores reflecting a better home learning-promoting environment. The Cronbach's α among items was 0.83. The score of HLE had a moderate correlation with maternal education level (r = 0.12 to 0.31), which suggested that the construct of HLE was independent from other indexes of SES. The latent score was estimated using IRT with a mean of zero and standard deviation of one.

Child, family and kindergarten characteristics. A background questionnaire completed by parents provided information on the following characteristics of children and families in the investigation: age, enrollment age, maternal education, family annual income and guardian of the child. Kindergarten characteristics were obtained via the teacher's questionnaire.

Children's age and enrollment age in months were recorded. Enrollment age was also recoded into six dummy variables measuring starting kindergarten at age 0 to 2 years, 2 to 2.5 years, 2.5 to 3 years, 3 to 3.5 years, greater than 3.5 years, and start date unknown.

Maternal education status was measured by the total number of years of formal schooling completed by the mother. It was recoded as dummy variables (1 = Primary school or below, 2 = Middle school, 3 = Vocational school and 4 = Bachelor's degree or above). Family annual income was coded as 1 =< 12,000, 2 =

12,000 to 40,000 and 3 = 40,000. Maternal education and family annual income were used as indexes of socio-economic status, given their correlations with other indices of social class, such as marital status, household crowding, parental occupation, parental employment status and free lunch eligibility (Christian et al., 1998).

Guardian of the child was coded as 1 = two parents, 2 = one of the parents and 3 = grandparents or others. This variable was included to test the possibility of family structure differences in children's early psychological development.

Kindergarten level was according to the official classification of kindergartens (unclassified, community-level, city-level and province-level). Kindergartens funded by government are classified by authority into different levels, according to institution effectiveness as a means of quality management. Public kindergartens that are of highest quality are entitled province-level kindergartens, and those of least quality are in the unclassified group. Private kindergartens are not classified by the government, so they are also included in the unclassified group.

Analytic Procedures

Multilevel modeling provides a method of analyzing hierarchical data. MLwiN2.0 (Rasbash, Steele, Browne, & Prosser, 2004) was used to build two-level regression models. The first level is student level and the second level is kindergarten level.

$$\text{Level 1: } Y_{ij} = \beta_{0j} + \beta_{1j}X_{1ij} + \beta_{2j}X_{2ij} + \ldots + \beta_{pj}X_{pij} + e_{ij} \quad (1)$$

$$\text{Level 2: } \beta_{0j} = \gamma_{00} + u_{0j} \quad (2)$$

$$\beta_{1j} = \gamma_{10} \quad (3)$$

$$\begin{cases} u_{0j} \sim N(0, \sigma_{u0}^2) \\ e_{ij} \sim N(0, \sigma_e^2) \end{cases}$$

Predictors included gender, maternal education, family annual income, guardian type, kindergarten level, age, enrollment age in kindergarten (in year) and HLE.

Analysis was conducted in two steps. In the first step, enrollment age and HLE were regarded as dummy variables. Many regression models assume a linear relationship among variables when the relationship is meaningful but non-linear; and the potential bias from misspecification could be mitigated by using multiple dummy variables instead of continuous variables for measures, such as education and income. And by recoding enrollment age into a set of dummy variables, the effective size for each interval of starting age can be calculated. In the second step, another set of models was set up to directly explore the curvilinear relationship, as well as the moderation of HLE.

Effect sizes were given for predictor variables (Melhuish et al., 2009). Computation for effect size was as follows. For the binary explanatory variables: Effect size = β/σ; for the continuous explanatory variables: Effect size = $(2\beta \times SD)/\sigma$, where β is the model parameter estimate, SD is the standard deviation of parameter estimate and σ is the standard deviation at child level.

Data on one or more background characteristics are missing for some children. To retain these cases, the relevant regressors were set to zero and dummy variables were created to denote the presence of missing values (Magnuson, Ruhm, & Waldfogel, 2004). For example, for children missing data on family income, the binary variables were recoded to have a value of zero, and a dummy variable indicating missing data on family income was created.

Results

Enrollment age was firstly entered as a categorical variable, so that any possible non-linear relationship could be revealed. In the two-level model (see Table 3), with children and kindergarten characteristics and family background variables controlled, kindergarten enrollment age and HLE both showed significant effects on children's cognitive performances at the age of four. Effect sizes were calculated from the final model allowing for all other variables. Entering kindergarten between 2 and 2.5 years old resulted in the greatest effect on cognitive status (effect size = 0.26) compared with enrollment after 3.5 years old; however, enrollment before two-year-old did not result in better performance than the reference group. As two major indexes of SES, maternal education level and family annual income both significantly predicted 4-year-old cognitive performances, which was consistent with the results of previous researches. Controlling other variables, higher HLE could enhance cognitive scores by 0.27 to 0.29 *SD*. The level of kindergarten also significantly influenced the outcome.

Table 3

Two-Level Regression Analysis of Cognitive Performance and Problem Behaviors With Categorical Enrollment Age Variables (N =1,391)

	Cognitive performance			Problem behavior		
Fixed effect	*B*	*s.e.*	Effect size	*B*	*s.e.*	Effect size
Age	0.55	0.10	0.01***	-0.22	0.11	0.00*
Less than 24 months	0.33	1.11	0.03	-0.64	1.26	-0.06
24 to 30 months	2.58	0.91	0.26**	-1.72	1.04	-0.17
30 to 36 months	1.98	0.93	0.20*	-1.65	1.05	-0.17
36 to 42 months	1.96	0.84	0.20*	-2.28	0.96	-0.23*
Unknown	1.84	1.01	0.18	-0.90	1.15	-0.09
HLE medium	2.68	0.69	0.27***			
HLE high	2.94	0.89	0.29***			
Middle school	2.97	0.83	0.30***	-1.65	0.94	-0.16
Vocational school	5.05	1.00	0.51***	-2.10	1.14	-0.21
Bachelor's degree or above	6.31	1.11	0.63***	-3.71	1.26	-0.37**
12,000 to 40,000	1.23	0.63	0.12*			
> 40,000	1.34	0.75	0.13			
Two parents	2.18	0.92	0.22*			
Grandparents	1.25	1.11	0.12			
Community-level	-1.80	1.27	-0.18			
City-level	3.22	1.26	0.32*			
Province-level	3.99	1.19	0.40***			
Random effect	Variance component	*Df*	χ^2	Variance component	*Df*	χ^2
Between kindergarten	9.36	1	59.66***	9.36	1	60.12***
Within kindergarten	67.01			67.01		
-2LogL	9,891.26			10,252.81		

Notes. ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; *B* is the regression parameter; *s.e.* is standard error; *Df* is the degree of freedom; -2LogL is -2 times logistic likelihood; χ^2 is squared chi coefficient.

Similarly, a two-level regression model was built with problem behaviors as the outcome variable (see Table 3), and only significant variables were kept in the model. The higher the score was, the more problem behaviors the child demonstrated. As it can be seen in Table 3, higher maternal education (bachelor's degree or

above) significantly reduce children's problem behaviors. Children entering kindergarten between 3- and 3.5 -years old had fewer problem behaviors than their counterparts whose enrollment was delayed; however, children enrolled as young as two-year-old had no advantage over the "latecomers".

It can be seen that with the enrollment age coded as a dummy variables, enrollment age showed non-linear effects on both cognitive achievements and problem behaviors. Curved prediction functions could be expected for both cognitive performances and problem behaviors. Then enrollment age as a continuous variable (in year) and a quadratic term were then added into the regression models replacing the set of dummy variables of enrollment age. HLE was also entered as a continuous variable in order to explore the moderating effects of HLE.

Table 4

Two-Level Models of Cognitive Performance and Problem Behavior With Kindergarten Enrollment Age as Continuous Variable (N =1,233)

	Cognitive performance		Problem behavior	
	B	*s.e.*	*B*	*s.e.*
Fixed effects				
Intercept	-13.95	7.80	84.86***	9.02
Two parents	2.42*	0.95	-1.65	1.10
Grandparents	1.39	1.15	-1.63	1.33
Middle school	3.02***	0.88	-1.45	1.02
Vocational school	4.62***	1.07	-2.00	1.23
Bachelor's degree or above	6.23***	1.19	- 4.18**	1.36
Community-level	-2.02	1.25	-0.01	1.38
City-level	2.05	1.25	0.98	1.38
Province-level	1.77	1.23	0.30	1.34
12,000 to 40,000	1.43*	0.66	-1.79*	0.77
> 40,000	1.74*	0.79	-0.51	0.91
Age (in year)	11.13***	1.51	-4.99**	1.74
Enrollment age (in year)	5.26*	2.40	-6.28*	2.78
Enrollment age-sq.	-0.99*	0.41	1.076*	0.47
HLE	-5.35***	1.11	-2.25*	0.93
HLE × Enrollment age	4.22***	0.84	0.78**	0.30
HLE × Enrollment age-sq.	-0.73***	0.18		

Notes. ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; *B* is the regression parameter; *s.e.* is standard error.

Maternal education, family income, guardian type and chronological age all showed significant effects on children's cognitive performance at age four (see Table 4). The fixed effect of linear enrollment age on cognitive performance showed that children who attended kindergarten at elder ages seemed to perform better ($B = 5.26$, $p < 0.05$), but the trend was inversely U-shaped ($B = -0.99$, $p < 0.05$). The change of cognitive performance over enrollment age had the shape of an inverted U-shape peaking around 33-month-old; in other words, the positive effect on cognitive performance was not cumulated with earlier kindergarten attendance. The main effect of HLE on cognitive performance was significant, but the slope of HLE changed over enrollment age and also had the shape of an inverted U-shape as indicated by the coefficient of HLE ($B = -5.35$, $p < 0.001$), HLE × enrollment-age ($B = 4.22$, $p < 0.001$) and HLE × enrollment-age-square ($B = -0.73$, $p < 0.001$).

A model was established with behavioral performance as the outcome and the results were also presented in Table 4. Enrollment age had a curvilinear effect on problem behaviors showing that children who attended kindergarten at elder ages seemed to show fewer problem behaviors ($B = -6.28$, $p < 0.05$), but the trend was U-shaped ($B = 1.076$; $p < 0.05$); in other words, either advanced enrollment or delayed enrollment resulted in

more problem behaviors. Different from the results when HLE was entered as a categorical variable in Table 3, HLE when entered as a continuous variable had a significant main effect (B = -2.25, $p < 0.05$) as well as a significant interaction with enrollment age (B = 0.78, $p < 0.01$).

To further elaborate the interactions between HLE and enrollment age, two sets of functions were calculated from the regression results in Tables 3 and 4. An individual child's cognitive performance at age four can be presented as a function of enrollment age: Cognition = b_{10} + b_{11} (enrollment age) + b_{12} (enrollment age)^2 + X, in which b_{10} = -5.35 (HLE), b_{11} = 4.22 (HLE) + 5.26, b_{12} = -0.73 (HLE) -0.99, and X represents the effect of all the other controlled variables. By assigning integer values to HLE (from -3 to 3), a set of functions were obtained and their coefficients (i.e., b_{10}, b_{11} and b_{12}) were presented in Table 5.

Table 5

Regression Coefficients for Different Levels of HLE

	Cognitive performance			Problem behavior		
HLE	b_{10}	b_{11}	b_{12}	b_{20}	b_{21}	b_{22}
-3	16.05	-7.4	1.2	6.75	-8.62	1.076
-2	10.7	-3.18	0.47	4.5	-7.84	1.076
-1	5.35	1.04	-0.26	2.25	-7.06	1.076
0	0	5.26	-0.99	0	-6.28	1.076
1	-5.35	9.48	-1.72	-2.25	-5.5	1.076
2	-10.7	13.7	-2.45	-4.5	-4.72	1.076
3	-16.05	17.92	-3.18	-6.75	-3.94	1.076

An individual child's problem behaviors at age four can be presented as: Behaviors = b_{20} + b_{21} (enrollment age) + b_{22} (enrollment age)^2 + X, in which b_{20} = -2.25 (HLE), b_{21} = 0.78 (HLE) − 6.28, b_{22} = 1.076, and X represents the effect of other controlled variables. By assigning integer values to HLE (from -3 to 3), a set of seven functions of enrollment age were obtained and their coefficients (i.e., b_{20}, b_{21} and b_{22}) were presented in Table 5.

HLE with a score of -3 suggests very bad learning environment, while a score of 3 indicates a very favorable learning environment. From the functions for low HLE, it can be seen that early enrollment results in higher cognitive performances ($b_{11} < 0$, $b_{12} > 0$); however, early enrollment results in more problem behaviors (for problem behavior, $b_{21} < 0$, $b_{22} > 0$). Turning to the functions for middle HLE, a change in the pattern was found, and enrollment round 2.5- or 3- year-old has the highest cognitive performances and fewest problem behaviors ($b_{11} > 0$, $b_{12} < 0$; $b_{21} < 0$, $b_{22} > 0$). From the functions for high HLE, it can be seen that enrollment round three-year-old results in the highest cognitive performance ($b_{11} > 0$, $b_{12} < 0$), and delayed enrollment would increase problem behaviors ($b_{21} < 0$, $b_{21} > 0$).

Discussion

During the very period of expanding pre-school education, empirical evidence is highly necessary to provide implications for pre-school policies as well as pre-school practice. The combination of kindergarten education and HLE is certainly a topic of increasing importance to both parents and pre-school practitioners. The results suggest curvilinear relationship between kindergarten enrollment age and children's cognitive/behavioral performances. Interestingly, the effect of enrollment age is moderated by HLE: for low HLE children, early enrollment results in higher cognitive performances, but also more problem behaviors; for middle HLE children, enrollment round 2.5- or 3- year-old sees the highest cognitive performances and fewest

problem behaviors; for high HLE children, enrollment round three-year-old brings the highest cognitive performances without increasing problem behaviors.

The Optimal Enrollment Age

This study is an attempt to solve a practical problem when children should attend pre-school. Previous studies have posed different answers. Some researchers (Reynolds, 1995; Sylva et al., 2003) hold that earlier enrollment brings better cognitive performances; however, based on some evidence (Bickel et al., 1991; Warder, 1999), older children can benefit more than their younger counterparts. It seems that earlier researchers failed to reveal the curvilinear relationship with data of a limited range of enrollment age. In this study, advanced enrollment is referred to entering kindergarten as young as two-year-old and delayed enrollment means entering kindergarten for the first time after becoming three and a half years old. Results in this study indicated that advanced enrollment age did not advantage children's development when compared with children with middle enrollment age. Our finding also suggested that delayed enrollment was also disadvantaged ending up with lower cognitive scores.

Undoubtedly, the ideal profile of early development would be the most cognitive progress without sacrificing socio-emotional development. Does kindergarten hazard socio-emotional development while promoting cognition and intelligence? However, there are debates upon the effect on socio-emotional development. It seems reasonable that separation from mothers in early childhood will result in problem behaviors (Magnuson et al., 2004). Connell and Prinz (2002) found that the effect of attendance was more complex than thought of: children who started earlier were rated more favorably by teachers; but more extensive kindergarten, in other words, more hours a week, would lead to problem behaviors. Our finding revealed that there seemed to be an optimal enrollment age around three years old which could promote cognitive development without bringing more problem behaviors.

Curvy relationships were found for both cognitive performances and problem behaviors in the current study. In this sense, kindergarten attendance can be seen as a "dosage" effect and can be conceptualized as the age at entry or length of attendance. Children entering at appropriate ages or attending for adequate years may exhibit greater benefits than those with delayed or advanced attendance.

It is possible that some important factors are controlled for that affects both the enrollment age and child development (besides the controlled predictive variables). But, the difference in the relationship between enrollment age and cognitive performance in comparison to enrollment age and problem behaviors suggests that the results are not driven solely by selection bias. If particularly strong families send their children to kindergarten at a certain age and we are not able to adjust for that with the variables available, we should expect to see the highest effect size across both measures for children associated with that enrollment age. This is not the case here. The social-behavioral effects differ from the cognitive effects in detail (see Table 3).

The Effects of Enrollment Age on Children With Different Levels of HLE

The main effects of HLE and the interactions between enrollment age and HLE are also meaningful findings in this study. The HLE scale examines parents' behaviors promoting children's early learning, for instance, "reading books or picture books with children", "taking children to the park, zoo or children's museum" and "helping children with counting and arithmetic". Our results revealed that "what parents do" matters even when controlling for family income and maternal education, consistent with a previous study (Melhuish et al., 2009). "Who parents are" (in terms of education level, profession or socio-economic status)

undoubtedly has a great impact on children's early learning and development as proved by numerous studies, but it cannot be changed easily. However, parents could always moderate their own behaviors to create a better HLE for children.

The joint influence of kindergarten and family environment on children's early development is reflected in the interactions between enrollment age and HLE. The interactions can be seen as the moderating effects of HLE on enrollment age effects. Children with a poor HLE (no matter how wealthy their family is in terms of money) need special attention, for advanced enrollment would significantly promote their cognitive performances but would bring more problem behaviors. Parents and pre-school practitioners get caught in a dilemma here and perhaps the best solution for those parents is to change their own behaviors and spend more quality time with their children for the good of children's early development. For children who enjoy a good HLE, it may be harder to fit in the kindergarten environment since they have to share the teacher's attention as well as other resources with other children. Therefore these children cannot benefit from an advanced enrollment both intellectually and socio-emotionally. And placing young children with high HLE levels at kindergarten classrooms may well prove to be a waste of public pre-school education resources.

Limitations and Future Study

There are three limitations to the current study. First, without long-term evidence, it is difficult to determine how much weight to put on our current findings. Second, the measures of problem behaviors are limited and cannot provide a full picture of children's socio-emotional development. At last, we need to learn more about what happens inside the "black box" of kindergarten education. Future research should consider whether these associations are moderated by factors, such as kindergarten group sizes, staffing ratios and curriculums.

Conclusions

Recent efforts to extend and improve kindergarten access make this study of the enrollment age effects on children's cognitive and behavioral development particularly relevant to policy makers, parents and pre-school practitioners. Results from two-level models suggested a curvilinear effect of enrollment age and an interaction between enrollment age and HLE.

References

Aboud, F. E. (2006). Evaluation of an early childhood pre-school program in rural Bangladesh. *Early Child Research Quarterly, 21*(1), 46-60.

Barnett, W. S. (1995). Long-term effects of early childhood programs on cognitive and school outcomes. *The Future of Children, 5*(3), 25-50.

Berlinski, S., Galiani, S., & Gertler, P. (2006). *The effect of pre-primary education on primary school performance*. Retrieved from http://www.ifs.org.uk/wps/wp0604.pdf

Bickel, D. D., Zigmond, N, & Strayhorn, J. (1991). Chronological age at entrance to first grade, effect on elementary school success. *Early Childhood Research Quarterly, 6*, 105-117.

Bradley, R. H., Corwyn, R. F., McAdoo, H. P., & Coll, C. G. (2001). The home environments of children in the US part I, variations by age, ethnicity and poverty status. *Child Development, 72*, 1844-1867.

Caughy, M. O., DiPietro, J., & Strobino, M. (1994). Day-care participation as a protective factor in the cognitive development of low-income children. *Child Development, 65*, 457-471.

Christian, K., Morrison, F. J., & Bryant, F. B. (1998). Predicting kindergarten academic skills, interactions among child care, maternal education, and family literacy environments. *Early Childhood Research Quarterly, 13*(3), 501-521.

Connell, C. M., & Prinz, R. J. (2002). The impact of childcare and parent-child interactions on school readiness and social skills development for low-income African American children. *Journal of School Psychology, 40*(2), 177-193.

Chang, M., Park, B., & Kim, S. (2009). Parenting classes, parenting behavior, and child cognitive development in early head start: A longitudinal model. *The School Community Journal, 19*(1), 155-174.

Desai, S., Chase-Lansdale, P. L., & Michael, R. T. (1989). Mother or market? Effects of maternal employment on the intellectual ability of four-year-old children. *Demography, 26*, 545-561.

DiPasquale, G. W., Moule, A. D., & Flewelling, R. W. (1980). The birth date effect. *Journal of Learning Disabilities, 13*(5), 234-238.

Early Child Care Research Network. (2003). Does amount of time spending child care predict socio-emotional adjustment during the transition to the kindergarten. *Child Development, 74*(4), 976-1005.

Entwisle, D. R., Alexander, K. L., Cadigan, D., & Pallas, A. M. (1987). Kindergarten experience, cognitive effects or socialization? *American Educational Research Journal, 24*(3), 337-364.

Heckman, J. J. (2006). Skill formation and the economics of investing in disadvantaged children. *Science, 312*, 1900-1902.

Kamerman, S. B. (2001). *Early childhood education and care, international perspectives*. Retrieved from http://www.humanics-es.com/childcare_senate_testimony.pdf

Landvoigt, T., Muehler, G., & Pfeiffer, F. (2007). *Duration and intensity of kindergarten attendance and secondary school track choice*. Retrieved from http://www.ftp.zew.de/pub/zew-docs/dp/dp07051.pdf

Lin, H. H., Freeman, L. S., & Chu, K. L. (2009). The impact of kindergarten enrollment age on academic performance through kindergarten to fifth grade. *European Journal of Social Sciences, 10*(1), 45-54.

Loeb, S., Bridges, M., Bassok, D., Fuller, B., & Rumberger, W. R. (2007). How much is too much? The influence of pre-school centers on children's social and cognitive development. *Economics of Education Review, 26*(1), 52.

Lv, Z. (2008). The effect on the school readiness in children's school adjustment (Unpublished Master's Dissertation, Northeastern Normal University). in Chinese

Magnuson, K. A., Ruhm, C. J., & Waldfogel, J. (2004). *Does prekindergarten improve school preparation and performance?* Retrieved from http//www.nber.org/papers/w10452

Melhuish, E. C., Sylva, K., Sammons, P., Sirah-Blatchford, I., Taggart, B., & Phan, M. B., et al. (2009). Pre-school influences on mathematics achievement. *Science, 321*(29), 1161-1162.

National Institute of Child Health and Human Development Early Child Care Research Network. (2003). Does amount of time spending child care predict socio-emotional adjustment during the transition to the kindergarten. *Child Development, 74*(4), 976-1005.

Rasbash, J., Steele, F., Browne, W., & Prosser, B. (2004). *A user's guide to MLwiN version 2.0.* London: Institute of Education.

Reynolds, A. J. (1995). One year of pre-school intervention or two, does it matter? *Early Childhood Research Quarterly, 10*, 1-31.

Robinson, S. L. (1986). School entrance age and the three R's, research, reality and recommendations. *Kappa Delta Pi Record, 3,* 3-7.

Sammons, P., Elliot, K., Sylva, K., Melhuish, E., Siraj-Blatchford, I., & Taggart, B. (2004). The impact of pre-school on young children's cognitive attainments at entry to reception. *British Educational Research Journal, 30*(5), 691-712.

Shonkoff, J. P., & Phillips, D. (2000). *From ueurons to neighborhoods: The science of early child development*. Washington: National Academies Press.

Sun, L. (2007). The effect of home environment on pre-school children's school readiness (Unpublished Master's Dissertation, Northeastern Normal University). in Chinese

Sylva, K., Melhuish, E., Sammons, P., Siraj-Blatchford, I., Taggart, B., & Elliot, K. (2003). *The effective provision of pre-school education (EPPE) project: Findings from the pre-school period* (Research Brief RBX15-03). London: EPPE, The Institute of Education, University of London.

Tobin J. J., Wu, D. Y. H., & Davidson, D. H. (1989). *Pre-school in three cultures*. New Haven and London: Yale University Press.

Warder, K. (1999). *Born in December, ready for school?* Retrieved from http://www.eric.ed.gov/ERICWebPortal/contentdelivery/servlet/ERICServlet?accno=ED439815

Wu, M., Adams, R. J., Wilson, M. R., & Haldane S. A. (2007). *ACER ConQuest version 2.0: Generalized item response modeling software*. Victoria: ACER Press.

Xia, J., & Zhang, X. (2010). Strengthening governmental responsibility, improving the three-year universalization of early childhood education—The study of the three-year universalization policies of Sichuan province. *Pre-school Education Research, 8*, 21-26. (in Chinese)