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The relationship between infant peer interactions and cognitive development: Evidence from rural China

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Abstract

Social interactions in infancy have implications for long-term outcomes. This study uses data from a sample of 1412 rural Chinese infants aged 6–12 and 24–30 months to examine the relationship between peer interactions and cognitive development. Over 75% of the infants in this sample had less than three peers and around 20% had no peers in both periods. The prevalence of cognitive delays is high within this sample and increases as infants age. Multivariate analysis reveals that peer interaction is significantly associated with cognitive development. Heterogeneous analysis suggests that peer interactions and mental development may be related to the child's primary caregiver and the distance from the child's household to the center of their village.

Keywords

Cognitive development, infant development, peer interaction, rural China

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Introduction

The first years of life are critical for a child's lifelong outcomes due to rapid growth and brain development during this period (Almond and Currie, 2011). During this early stage of life, a complex set of socioeconomic, environmental, and genetic contributors can influence a child's cognitive development (Maggi et al., 2010). Among these factors, social interactions have been shown to positively influence children's cognitive development (Poobalan et al., 2007). For example, children who have more interactions with their mothers in infancy have been shown to exhibit higher levels of cognition when they are older (Bakeman and Brown, 1980).

Peer interaction is one form of social interaction that has been shown to benefit the cognitive development of young children. Researchers have found that interactions with peers exert a stronger influence than adult–child interactions on the learning behavior of children aged 14–18 months (Ryalls et al., 2000). Peer interaction may influence the way infants interact with others and the world around them, as evidence suggests that infants as young as 10 months of age are responsive to the actions and behavior of unfamiliar peers (Eckerman and Whatley, 1977).

Further research on the value of peer interaction during infancy may be important in developing regions or countries, such as rural China. Children in these areas are often exposed to risks that are associated with developmental delays (Grantham-McGregor et al., 2007; Walker et al., 2011). Recently, high rates of developmental delays have been observed in rural areas of China. Luo et al. (2015) found that 20% of a sample of 1808 infants aged 6 to 12 months old in rural Shaanxi Province suffered from some degree of cognitive impairment. When children in this sample reached 24–30 months of age, more than half were cognitively impaired (Luo et al., 2015). Rates of developmental delays were also found to be high in a sample of rural infants from Hebei and Yunnan provinces (Yue et al., 2016). Recently, Wei et al. (2015) found that 39.7% of 1–35-month-old children in their rural China sample (2837) suffered from some sort of cognitive, social, or physical developmental delay.

In addition to the high prevalence of developmental delays, evidence suggests that rural infants are likely to have few opportunities to interact with their peers. In recent decades, the number of children in China's rural areas has significantly decreased due to family planning policies. Wang (2013) found that the second-child fertility rate among women of childbearing age in rural areas fell from 92% in 1982 to 71% in 1990, and then to 50% in 2000. It is likely that this trend has continued, as an estimated 38 million Chinese children under four years of age were the only child in their household in 2010, including 27 million children in rural areas (National Bureau of Statistics, 2010). Geographic distance may also limit children's opportunities to interact with their peers due to the fact that residential space is widely dispersed in rural China (Li, 2009).

The goal of this paper is to assess the relationship between infant peer interactions and cognitive development. To accomplish this, our study has two specific objectives. First, we seek to describe the prevalence of peer interactions and

cognitive development delays among our sample of infants in Shaanxi Province over two time periods. Then, we examine whether a relationship exists between the peer interactions and cognitive development of infants. To date, few studies have sought to investigate the relationship between cognitive development and peer interactions during infancy. Additionally, to our knowledge, no research has sought to examine this relationship in a developing country setting, such as rural China.

The rest of this paper is organized as follows: the next section presents our sample selection and research methodology; the third section presents the results of our analyses; the fourth section discusses our findings; and the fifth section concludes the paper.

Data

Sampling

Our study was conducted in 2013 and 2014 in 11 nationally designated poverty counties in Shaanxi Province. The area is predominantly Han Chinese and had a per capita annual income of about 6503 RMB in 2013 (Shaanxi Provincial Bureau of Statistics, 2014), which was lower than the 8896 RMB national average for rural areas in the same year (National Bureau of Statistics, 2014). From each of these 11 counties, all townships (the middle level of administration between county and village) were selected to participate in the study, excluding the township that housed the county seat. In total, 174 townships were included in the study.

The sample villages were selected in April 2013 as follows. To meet the power requirements of a larger, interventional study (not reported in this paper), we required a minimum of five children in each township. With this requirement in mind, we first randomly selected one village (with a population of 800 or more) from each township to participate. A list of all registered births over the past 12 months was obtained from the local family planning official in each village. All children in our designated age range were enrolled in the study. If a village had fewer than five children in our designated age range, we randomly selected an additional village in the same township for inclusion in the study, and continued to randomly select additional villages until five children per township had been found.

The data used in this study were collected from sample households over two four-week periods in April 2013 and October 2014. In the first period of survey collection, the sample children were aged 6–12 months, and after 1.5 years we tracked and re-surveyed the same sample households when the infants were 24–30 months of age. Overall, our study uses data from 1412 households in 351 villages across 174 townships.

Data collection

In both waves of surveying, teams of trained enumerators collected socioeconomic information from all households participating in the study. Each child's primary

caregiver was identified and administered a detailed survey on parental and household characteristics, including each child's gender and birth order, maternal age and education, whether the family was receiving Minimum Living Standard Guarantee payments (a poverty indicator), and the distance from the child's home to the center of the village.

The second survey block collected information on the peer interactions of our sample children. To do so, we asked the following questions during the first round of surveying in 2013 when sample children were aged 6–12 months: 'How many children aged 0 to 5 months does your child often play with? How many children aged 6 to 12 months does your child often play with? How many children aged 12 to 18 months does your child often play with?' In 2014, we adjusted the questions in accordance with the child's age and asked: 'How many children aged 24 to 30 months does your child often play with? How many children of other ages does your child often play with?' We totaled the responses in each period to determine the prevalence of peer interactions.

In the third block of the survey, all infants were assessed with the Bayley Scales of Infant Development (BSID), an internationally validated test of infant cognitive and motor development. This test is extensively used in the psychological literature and is listed by the American Psychiatric Association as a standard way to diagnose certain developmental disorders (American Psychiatric Association, 2000). The test was formally adapted to the Chinese language and environment in 1992, and scaled according to an urban Chinese sample (Yi et al., 1993). Following the example of other published studies that use the BSID in China, the officially adapted version of the Mental Development Index (MDI) test was used in this study (Chang et al., 2013; Li et al., 2009; Wu et al., 2011). The test has an inter-rater reliability of 0.99 and a high measure of test-retest reliability (0.82). The parallel forms reliability is also high (0.85), indicating that test scores are consistent even when the methods or instruments used vary (Yi, 1995).

All BSID enumerators attended a week-long training course on how to administer the BSID, including a 2.5-day field training program. The test was administered by one-on-one in each household using a set of standardized toys and a detailed scoring sheet. The BSID takes into consideration each infant's age in days, as well as whether he or she was born prematurely. These two factors, combined with the infant's performance on a series of tasks using the standardized toy kit, contribute to the determination of the child's MDI score, which evaluates memory, habituation, problem solving, early number concepts, generalization, classification, vocalizations, and language to produce a measure of cognitive development. Children's MDI scores were standardized to a mean of 100 and standard deviation of 16; MDI scores range between 50 and 150. Children failing to achieve the minimum MDI score (50) were assigned a score of 49 (Moore et al., 2012). Moderate or severe cognitive impairment was defined as $MDI < 70$, or two standard deviations below the mean, and mild cognitive impairment was defined as $70 \leq MDI < 80$. This study is one of the largest studies using the BSID in China,

and to the best of our knowledge, the only administration of the BSID ever conducted in poor rural counties in China.

Statistical analysis

All statistical analyses were performed using STATA 13.0. *P*-values below 0.05 were considered statistically significant. To assess the relationship between an infant's peer interactions and MDI score, we used the following model

$$MDI_{ict} = \alpha + \beta \cdot Peer_{ict} + \gamma \cdot X_{ic} + \lambda \cdot s_c + \varepsilon_{ict}$$

where the dependent variable, MDI_{ict}, indicates the MDI score of infant i in village c at time t. $Peer_{ict}$ is the number of peers, and, therefore, β the parameter of interest. The term X_{ic} is a vector of covariates that are included to capture and control for the characteristics of infants and their households, such as: *gender*; *age*; *premature birth*; *birth order*; *mother is the primary caregiver*; *maternal age*; *maternal educational level*; *Minimum Living Standard Guarantee payment receipt*; and *distance from home to the village center*. Other non-time varying village effects are captured by λ. We account for the clustered design by constructing Huber–White standard errors clustered at the village level.

Results

Sample characteristics

The basic socioeconomic and demographic characteristics of study participants collected in the first wave of the survey are reported in Table 1. Of the 1412 children in this study, slightly over half (53.0%) were male and 60.3% were the first-born child in their household. The mother was the primary caregiver for 82.7% of the children in the sample at baseline; otherwise, the grandmother was the primary caregiver. The majority of the mothers (82.7%) had completed fewer than nine years of schooling and 51.0% were over 25 years of age. Slightly less than one-quarter (23.4%) of sampled families reported receiving the Minimum Living Standard Guarantee Payments, a form of government welfare for the lowest income families nationwide. Additionally, about half (51.6%) of the homes of the sample children were further than one kilometer from the center of the village.

Prevalence of peer interactions

Table 2 presents the prevalence of peer interactions for both study periods. We find that in both study periods the majority of children had two or fewer peers with whom they often played. Specifically, 76.5% of infants had three or fewer playmates when they were 6–12 months old and this number increases slightly to 78.5%

Table 1. Basic characteristics of sample children in rural Shaanxi Province ($n = 1412$).

Characteristics	Frequency (n)	Percentage (%)
Gender		
Male	749	53.0
Female	663	47.0
Is the child premature?		
Yes	164	11.6
No	1248	88.4
Birth order of child		
First	851	60.3
Second or higher	561	39.7
Mother is primary caregiver		
Yes	1168	82.7
No	244	17.3
Maternal educational level (years)		
≤ 9	1168	82.7
> 9	244	17.3
Maternal age		
Age ≤ 25	692	49.0
Age > 25	720	51.0
Family receives minimum living standard guarantee		
Yes	331	23.4
No	1081	76.6
Distance from home to the center of village		
$\leq$ 1000 m	683	48.4
$>$ 1000 m	729	51.6

Note: Data are presented as frequency and percentage for all children.
Source: Authors' own data.

when sampled children were 24–30 months old. In addition, a number of children in our sample did not have any peers with whom they regularly interacted in either period. Our data show that 22.0% of children aged 6–12 months and 18.5% of children aged 24–30 months did not have any peers with whom they regularly played.

Nature of cognitive development

Table 3 depicts the nature of cognitive development of children in our sample over the two study periods. The mean MDI score in our sample was 96.6 when sample

Table 2. Prevalence of peer interaction among sample infants ($n = 1412$).

	Number of peers				
	0	1	2	3	>3
6–12 months of age					
Frequency (n)	310	319	269	180	334
Percentage (%)	22.0	22.6	19.1	12.8	23.5
24–30 months of age					
Frequency (*n*)	261	311	299	237	304
Percentage (%)	18.5	22.0	21.2	16.8	21.5

Source: Authors' own data.

Table 3. Mental Development Index (MDI) scores of sample children in rural Shaanxi Province ($n = 1412$).

	Mean MDI score	Standard deviation	Difference from expected mean (100)	*p*-value
6–12 months of age	96.6	17.1	–3.4	0.00
24–30 months of age	80.7	22.1	–19.3	0.00

Note: Data are presented as mean standard deviation for all children.
Source: Authors' own data.

infants were aged 6–12 months of age and decreased to 80.7 when the sample infants were 24–30 months of age. Additionally, we find that both of these measures are lower and significantly different (at the 1% level) from the standardized mean MDI score of 100, which represents an average level of cognitive development within the context of China (Yi et al., 1993).

Prevalence of cognitive delays

Table 4 presents the prevalence of varying degrees of cognitive developmental delays of sample infants with MDI scores between 70 and 80 (mild developmental delay) and less than 70 (moderate/severe development delay). We found that the prevalence of any degree of developmental delay increased from 14.3% when our sample was aged 6–12 months to 49.5% when our sample was 24–30 months of age. Our data suggests that this increase in the prevalence of developmental delays was driven by an increase in moderate/severe cognitive delays (Figure 1). We find that the prevalence of moderate/severe cognitive delays increased 27.1 percentage points over the course of the study period (from 7.3% to 34.4%) while the

Table 4. Cognitive impairment of sample children in rural Shaanxi Province ($n = 1412$).

	Frequency (n)	Percentage (%)
Any (Mental Development Index (MDI) <80)		
6–12 months of age	202	14.3
24–30 months of age	699	49.5
Mild ($70 \leq MDI < 80$)		
6–12 months of age	99	7.0
24–30 months of age	214	15.2
Moderate or severe ($MDI < 70$)		
6–12 months of age	103	7.3
24–30 months of age	485	34.4

Note: Data are presented for all children.
Source: Authors' own data.

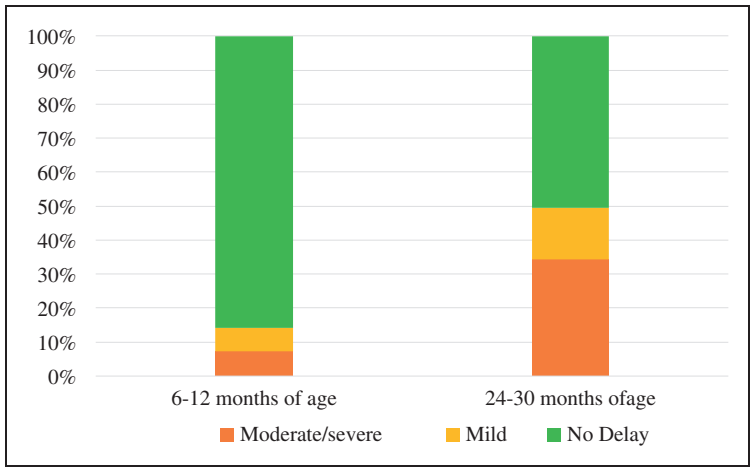

Figure 1. The prevalence of cognitive delays among sample infants in Shaanxi Province, China. *Source*: Authors' own data.

prevalence of mild cognitive delays only increased 8.2 percentage points over the same period (from 7.0% to 15.2%).

While it is beyond the scope of this paper to empirically identify the reasons for the sharp rise in the proportion of children suffering from cognitive delays, the literature clearly identified two possible sources of stress that lead to poor cognition

(Maggi et al., 2010). Poor nutrition and the absence of stimulation are the two main reasons that a child may become developmentally delayed. In another paper, it was shown within our sample that between 6–12 to 24–30 months the nutrition of children, while not overly good, is actually improving (Luo et al., 2016). Hence, if nutrition is improving while cognition is deteriorating, this would seem to suggest that poor nutrition is not driving the rise of the proportion of rural children in our sample who are developmentally delayed.

In contrast, children in rural China are clearly under-stimulated. According to Sylvia et al. (2017), even when children are 18–30 months old, a large proportion of parents are not spending time in activities that are thought to be key to stimulating the development of infants and toddlers. For example, less than 15% of caregivers regularly tell stories to their children; less than five percent read to their children. In a randomized controlled trial that intervened in a subsample of the overall sample of 18- to 30-month-old toddlers with a parenting training program, it was found that when caregivers spent time engaged in activities (including story-telling and reading) designed to stimulate their children's development, the cognition scores of children rose significantly. Clearly, these results are consistent with an interpretation of our data that suggests that the fall in cognition of a large proportion of children in the sample is due to under-stimulation.

The association between peer interaction and the prevalence of cognitive delays[1]

We present cognitive development by peer interaction levels in Table 5, which shows a significant and positive association between peer interaction and MDI scores. At 6–12 months of age, sample infants with at least one peer had a mean MDI score 4.6 points higher than infants without any peers, significant at the 1% level (column 1). When infants in our sample reached 24–30 months of age, this difference was even larger; the mean MDI score of infants with at least one peer was 6.2 points higher than infants without any peers, significant at the 1% level (column 2).

Since factors other than peer interactions may affect cognitive delays, we control for individual and household characteristics in our multivariate analysis. Our findings show that infants with at least one peer with whom they often interact had MDI scores 4.2 points higher than infants without peers at 6–12 months of age, significant at the 1% level (column 3). When children in our sample reached 24–30 months of age, infants with at least one peer had MDI scores 5.6 points higher than infants without any peers, significant at the 1% level (column 4).

Heterogeneous analysis

In order to examine whether certain household characteristics are associated with peer interaction and MDI scores, we present a heterogeneous analysis of these factors in Table 6. Our data suggest that a child's interaction with peers is significantly associated with whether or not the child's primary caregiver is his or her

Table 5. The correlation between child's peer interactions and his or her development using a multivariate ordinary least squares model ($n = 1412$).

	Mental Development Index (MDI)		MDI	
	6–12 months of age (1)	24–30 months of age (2)	6–12 months of age (3)	24–30 months of age (4)
Child has any peers (1 = yes; 0 = no)	4.6*** (0.9)	6.2*** (1.5)	4.2*** (0.9)	5.6*** (1.6)
Gender (1 = male; 0 = female)			–0.9 (0.7)	–2.6 (1.6)
Is the child premature? (1 = yes; 0 = no)			–1.9 (1.2)	1.3 (3.0)
Birth order of child (1 = first; 0 = second or higher)			1.3 (1.4)	1.6 (1.7)
Mother is primary caregiver (1 = yes; 0 = no)			0.5 (1.1)	5.6*** (1.6)
Maternal age (1 = older than 25; 0 = younger than 25)			–0.3 (1.2)	2.2 (1.7)
Maternal educational level (1 = over 9 years; 0 = less than 9 years)			2.0 (1.5)	8.7*** (1.7)
House distance from village center (1 = further than 1 km; 0 = closer than 1 km)			–1.8 (1.1)	–3.9*** (1.1)
Family receives Minimum Living Standard Guarantee (1 = yes; 0 = no)			–0.7 (1.0)	–3.9** (1.6)

Notes: Standard errors in parentheses.
**significant at 5%; ***significant at 1%.
Source: Authors' own data.

mother. In both survey periods, children whose mothers were their primary caregivers were significantly more likely to have peers with whom they often played. In contrast, children being cared for by grandmothers were less likely to have peers (significant at the 1% level). Our results also showed that the distance from a child's home to the village center was negatively related to both peer interactions and MDI score in both periods (significant at the 1% level).

Discussion

Our research uncovers evidence of a high prevalence of cognitive delays among infants in rural China that appears to be related to low levels of peer interaction.

Table 6. Results of multi-variate regressions between child characteristics and types of peer interaction and Mental Development Index (MDI) ($n = 1412$).

	Number of peers		MDI	
	6–12 months of age (1)	24–30 months of age (2)	6–12 months of age (3)	24–30 months of age (4)
Gender (1 = male; 0 = female)	0.0	–0.1	–0.9	–2.6**
	(0.1)	(0.1)	(0.9)	(1.2)
Is the child premature? (1 = yes; 0 = no)	–0.1	–0.2	–1.9	0.9
	(0.2)	(0.2)	(1.4)	(1.8)
Birth order of child (1 = first; 0 = second or higher)	0.2	0.1	1.4	1.6
	(0.2)	(0.1)	(1.2)	(1.5)
Mother is primary caregiver (1 = yes; 0 = no)	1.0***	0.4***	1.2	2.2
	(0.2)	(0.1)	(1.2)	(1.2)
Maternal age (1 = older than 25; 0 = younger than 25)	–0.2	–0.1	–0.4	2.1
	(0.2)	(0.1)	(1.1)	(1.4)
Maternal educational level (1 = over 9 years; 0 = less than 9 years)	0.2	0.2	2.2	8.9***
	(0.2)	(0.1)	(1.3)	(1.6)
House distance from village center (1 = further than 1 km; 0 = closer than 1 km)	–0.7***	–0.5***	–2.2**	–4.3***
	(0.1)	(0.1)	(0.9)	(1.2)
Family receives Minimum Living Standard Guarantee (1 = yes; 0 = no)	–0.0	0.1	–0.7	–3.9***
	(0.2)	(0.1)	(1.1)	(1.4)

Source: Authors' own data.

Over 75% of infants in our sample had less than three peers with whom they regularly played, and around 20% had no peers with whom they often played. This is of concern in light of evidence that increased social interaction during infancy can lead to positive developmental impacts that persist throughout an individual's life.

We also found rates of cognitive delay that are much higher than would be expected in a normal population of infants. Yi et al. (1993) found (using the BSID) that only 11.7% of infants aged 2–30 months in their urban Chinese sample suffered from cognitive delays (MDI < 80). However, using the same measure, our study found that among our rural sample, 14.3% of 6–12 months-old infants and 45.9% of 24–30 months-old infants had MDI measures below 80. This difference in the prevalence of cognitive delays suggests that the conditions in rural China today are such that children are not developing appropriately and may demonstrate that the gaps in human capital accumulation between rural and urban children start in infancy.

Our results also show that infants whose mothers are their primary caregivers are significantly more likely to have more peers and infants whose homes are within one kilometer of the center of their village are significantly more likely to have more peers and higher MDI scores. These findings are of concern within the context of rural China for several reasons. First, many Chinese children are left behind in the countryside with surrogate caregivers when their parents migrate for work, and the number of 'left-behind children' has increased in recent years (Zhou et al., 2015). This means that the number of children being raised by a caregiver other than their mother is high across rural China. Additionally, rural residences are often widely dispersed geographically (Li, 2009), and we find that about half of the infants in our sample lived over a kilometer from the center of their village. Taken together, these factors likely reduce the number of opportunities rural infants have to interact with peers.

We believe our research represents a contribution to the literature on infant–peer interaction due to its large sample size and standardized measures of infant cognitive development. However, our study still suffers from several limitations. First, we can only report on the quantity of an infant's peers and can say nothing about the quality of these interactions. Also, we rely on caregiver reports of infant–peer interactions, and therefore our responses may suffer from recall bias.

Conclusion

Overall, our findings suggest that cognitive developmental delays are common among our sample of rural Chinese infants. The extent of this problem is of concern in a country that has already reached middle-income status and suggests that inequality in human capital between China's rural and urban areas may begin as early as in infancy. This has the potential to affect China's overall economic productivity in the long run. Research has shown that interventions made early in a child's life have higher returns to human capital development than interventions targeting older children (Heckman, 2006). With this understanding, investing in rural infants and young children may help to promote productivity in China's economy and society.

Given the demonstrated relationship between peer interactions and infant cognitive development, we suggest that government administrative bodies implement programming to disseminate information on the value of peer interaction to caregivers of young children in rural China. One government agency that could run such a program is the Population and Family Planning Commission (PFPC), which has relatively easy access to every village in China. With China's one-child policy ending, the PFPC is looking for a new institutional mission, and it has turned its attention to early child development (Greubel and Van der Gaag, 2012). Given that the PFPC already has institutional reach and experience in conducting village outreach and running informational campaigns, it is well positioned to distribute information regarding early child development.

Another possible policy solution is establishing early childhood education centers in rural areas of China. Early childhood education programming has been shown to have long-term cognitive, academic, and social developmental benefits for children (Barnett, 1998; Coolahan et al., 2000). Our findings suggest that participation in these forms of early childhood education may be especially important because they offer rural infants and children opportunities to interact with peers. Though most examples of early childhood education programming exist in developed countries (Currie, 2000), one example from South Africa suggests that it can also benefit children in less-developed areas of a middle-income country. Dawes et al. (2012) found that children from rural and peri-urban areas who attended early childhood education programs where teachers had received training performed better than peers who had not attended these programs at five years of age. Implementing similar programming may have the potential to improve the developmental outcomes of infants and young children in rural China.

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Note

1. We also ran a household fixed model and found that when children in our sample had at least one peer, it increased their Mental Development Index score by 0.6 points on average (significant at the 5% level).

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