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Intelligent Robots and Rural Children in China

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Relative to their urban counterparts, rural children have highly limited access to education and lack support and care. This study used 156 rural children to evaluate an innovative approach, by the Ensan Charity Foundation to improve educational resources and care for rural children in China. The findings indicate that on average, the children used the foundation's Xiao En Intelligent Robots 1.3 hours daily. The usage of and satisfaction with the robots appear to have strong and positive effects on life quality, while the use of other electronics had negative effects on life quality. The results further indicate that both use of and satisfaction with the functions of conversation, storytelling, and singing advanced child life quality across various dimensions, including physical, emotional, social, and academic. Policy and practice implications were discussed.

Keywords: Rural children, migration, China, social innovation, intelligent robots

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Introduction

Since the 1978 economic reform, China has experienced an intense period of industrialization and urbanization. Urban areas have been rapidly developed, while labor demand has increased. As a result, a large number of rural workers have migrated from rural to urban areas for employment opportunities, giving rise to an emerging class of migrant and left-behind children in China (Chan, 2010; Lu et al., 2016). According to a definition used by the National Bureau of Statistics of China and the United Nations, "migrant children" refers to the population of individuals, under the age of 18, who have left their original place of residence and migrated to another place for more than 6 months. By contrast, the "left-behind children" are children who live in their original place of residence while one or both of their parents have migrated (National Bureau of Statistics of China, UNICEF China, UNFPA China, 2017). In 2015, there were about 271 million children living in China, with 51% of them lived in rural areas. About 25% of children, or 68.7 million, have been identified as left-behind children, with 40.5 million were rural left-behind and the rest were urban left-behind children. Another 13% of children have been identified as migrant children (National Bureau of Statistics of China, UNICEF China, UNFPA China, 2017). The Ministry of Civil Affairs (MCA) (2016) defines left-behind children as those who are under the age of 16 and live in their original place of residence while either (1) both parents have migrated elsewhere to work, or (2) one parent has migrated to work and the other has no guardianship capability. Under this more restrictive definition, in 2015, there were about 9 million left-behind children in rural China. Using the MCA's definition as a low-bound estimate and the Bureau of Statistics of China and Union Nations' standard as high-bound estimate, in 2015, the number of left-behind children in China ranged from 9 million to 69 million. The issues of migrant and left-behind children were resulted from the implementation of the Chinese Household Registration System. In 1958, the Chinese government enforced this system to control population mobility (Chan, 2010). By employing an identification system – called *hukou* – the government organized citizens into two classes: urban and peasant (the rural class). In 2015, 56.1% of national population were considered "urban". The rest of the national population, the rural population, was deprived of the right to settle in cities. Furthermore, they were excluded from many benefits that the urban class has (UNICEF, 2017; Chan, 2010; Chan & Buckingham, 2008). Even so, the migrant population in cities continues to increase due to job opportunities. Restricted by the Household Registration System, however, migrants must work with their rural identification. Thus, they struggle with a difficult decision: whether to allow their children to relocate with them or to leave them in the care of relatives and neighbors back in their original rural communities (Lu et al., 2016).

Child Development in Rural Areas

Various research has found that rural children are at higher risk for disadvantaged situations and generally face more challenges, including: being victims of child sexual abuse (Lin et al, 2011; Gillham et al., 1998); developing psychological and behavioral issues, such as depression, anxiety, feelings of loneliness, and alcohol use (He et al., 2012; Ling et al., 2015; Jia, & Tian, 2010; Liu et al., 2009); having limited access to quality educational resources (Yang et al., 2014); and, finally, experiencing fragile or inadequate guardianship (Lu et al., 2016; Zhou et al., 2014). Based on a meta-analytic review, Wang and Mesman (2015) found that parent migration causes a multitude of diverse impairments to migrant and left-behind children's emotional functioning, social functioning, and school functioning.

Specifically, empirical studies have showed that rural children are at a higher risk of experiencing health issues than their urban peers (Liu et al, 2013; Gao et al., 2010; Jiang et al., 2015). Liu and her colleagues (2013) used data from the China Health and Nutrition Survey (CHNS) to examine the effect of socioeconomic changes on rural children's health and nutritional status. The dataset contained 15,719 cases, including 3,724 urban cases and 11,995 rural cases, collected over the time period between 1989 and 2006. They found that a lower proportion of rural children reached age-appropriate height and weight than that of the urban children; 3% of rural cases was underweight, compared to 1% of urban cases. Furthermore, rural samples had lower rate of health insurance coverage (18% versus 24%) and preventive health care use (4% versus 7%) than urban samples. The results indicated that rural children were more likely to have poorer health and nutritional status than urban children. Other studies found that left-behind students were more inclined to smoke cigarettes and drink alcohol. A higher proportion of male left-behind students reported skipping breakfast, while female left-behind students had a higher risk of excessive sugar intake through consumption of beverages high in sugar (Gao et al., 2010; Jiang et al 2015).

Jia and Tian (2010) conducted a cross-sectional study to examine the risk factors of rural children's loneliness. The results showed that grandparents' guardianship led to an increase of 2.3 points on children's loneliness scores when compared to scores of children who were under parental guardianship. When children communicated with parents on moderate or low frequency, as opposed to high frequency, their loneliness scores increased 2.1 and 3.2 points, respectively. When children identified a moderate or bad parent-child relationship, their scores increased 2.3 and 4.7 points, respectively, with scores of children who described good parent-child relationships as a baseline. Lu and her colleagues (2016) indicated that rural children valued parental praise more than their urban counterparts, which might be a result of an earlier separation from their parents.

Luo and her colleague found that left-behind children were less likely to have full-time food care (79%) compared to other rural children (84%), likewise, the former had lower daily food intakes in meat, fish, and eggs (143 grams/day) than the latter (157 grams/day). As a result, left-behind children had poor health evidenced by low hemoglobin (112.9 vs. 113.8 g/L) and high anemia (31.1% vs. 26.2%) compared to other rural children (Luo et al., 2008). Lu and her colleagues (2018) also pointed out that in addition to caring for children, grandparent caregivers are also responsible for maintaining the household and shouldering heavy agricultural work, both of which require much time and energy. Subsequently, their ability to provide sufficient guardianship to rural children is weakened. Based on 2,048 cases, Lu and her colleagues (2016) also demonstrated that, due to less parental restriction, rural children were more likely than their urban peers to spend more time watching television.

Education quality and school environment have a significant effect on students' short-term achievement (Darling-Hammond, 2000; Lafortune et al., 2018) and long-term success (Chetty et al., 2014; Chetty et al., 2011). Weaker educational environments, caused by low financial support, poor infrastructure, poor academic credentials of teachers, and higher teacher-student ratio, place rural students in a more disadvantaged situation than urban students (Hu, 2008; Hu et al., 2014; Zhang et al., 2015; Lu et al., 2016). By analyzing the 2005 1% Population Sampling Survey data, Zhang and her colleagues (2015) found that for the rural population aged 15 to 65, despite the average duration of schooling increasing from 4 to 9 years from 1939 to 1983, the urban-rural gap did not improve. Instead, the urban population had approximately 4 more years of average schooling. Furthermore, only 70% of rural children were able to finish junior high school, compared to 100% of urban children who were able to complete junior high school completion. About 54% of urban children enter college/university, as compared to a mere 2% of rural peers.

Intelligent Robots and Rural Children

With the development of artificial intelligence (AI) robots, companies have developed various AI robots to assist daily living for people in need. For example, Intuition Robotics, developed in 2015, has implemented technology, such as Cognitive Computing, and Natural Communication, to create intelligent robots that are capable of autonomous decision-making and emotional connection (Intuition Robotics, 2017). Furthermore, intelligent robots have been developed and utilized for surgical use as well, such as ARTEMIS, a two-arm device controlled by surgeons (Lanfranco et al., 2004; Schurr et al., 2000). These innovative strategies are being applied to resolve social problems and issues. Generally, social innovation is the creation of new ideas, procedures, or activities, based on existing ones, for the purpose of solving social problems or meeting social needs. Social innovation is usually developed and diffused by organizations to meet their social purposes (Mulgan, 2007; Cajaiba-Santana, 2014). As opposed to business innovation, social innovation is driven by social needs rather than the motivation to maximize profits. It emphasizes solutions that increase social value (Donner, & Huang, 2017). Social innovation can reflect social relations, be inclined to social practice, and provide creative solutions in numerous fields, including equality, mental health, physical health, and poverty (Mulgan, 2007; Cajaiba-Santana, 2014). Social innovation has emerged from the increasingly intertwined efforts of non-profits, governments, and businesses.

The above development has made artificial intelligence robots a potential and innovative way to reduce education and care deficiency among rural children and to improve their overall well-being. Li Ensan Charity Foundation, established in 2013, has implemented the Xiao En Intelligent Robots project to achieve such goals. The Li Ensan Charity Foundation started to create the Xiao En Intelligent Robots in 2016. The robots equipped with education and care functions such as: knowledge on Chinese ancient history and poems; on-demand singing and storytelling capability; and ability to have private conversation; and a platform for communication with parents. After successful testing, the Li Ensan Charity Foundation started to distribute the Xiao En Intelligent Robots to rural children in 2017. The aim of this study is to evaluate the effects of the Xiao En Intelligent Robots on the well-being of rural children.

Methodology

Data

The data for this study came from three rural elementary schools in China. Li Ensan Charity Foundation selected these schools based on their disadvantaged status. All the students in Grade 1 and 2 in these schools received the robots in 2017. One school was in Nanchong of Sichuan province, while the other two were in Yueyang and Changde of Hunan province. We interviewed all 172 students in Grade 1 and 2 in these three schools between March and June of 2018. Excluding 16 cases with missing information on key variables, the final sample size was 156 students. Because of shortage of robots, 11 students did not receive the robots and were placed on a waiting list.

Measures

The dependent variable in this study is life quality as measured by the Pediatric Quality of Life Inventory (PedsQL), version 4.0, child report. The PedsQL is designed to assess health-related quality of life in children with high reliability and validity (Varni, et al., 2001). PedsQL 4.0 has been utilized to examine the association between children's health condition and quality of life. Research has demonstrated that children with chronic illness and suspected sleep-disordered breathing were more likely to have lower health-related quality of life (Varni e al., 2007; Crabtree et al., 2004). PedsQL has 23 items and covers four dimensions of life quality, including physical, emotional, social, and school functioning. Examples of items include "It is hard for me to do sports activity or exercise" and "I have low energy " for physical functioning; "I feel sad or blue" and "I have trouble sleeping " for emotional functioning; "I have trouble getting along with other kids" and "I cannot do things that other kids at my age can do" for social functioning; and "It is hard to pay attention in class" and "I have trouble keeping up with my schoolwork" as measures of school functioning. The students were asked to report the frequencies of these experiences in their daily lives in the past month, from "0" as "never" to "4" as "almost always." In the analysis, we followed the PedsQL coding scheme, and coded a value of "0" as "100", "1" as "75", "2" as "50", "3" as "25", and "4" as "0". The average score of the PedsQL scale is considered the overall life quality, which ranges from 0 to 100, with higher scores representing greater life quality.

The main independent variable is the usage of Xiao En Intelligent Robots. The usage was measured in two ways: (1) whether or not the robot was used; and (2) duration of usage in hours. We further examine usage in both continued and categorical measurement. In addition to the usage of the robots, we measure the usage and satisfaction of each function of the robots, including communicating with parents, singing, storytelling, reciting ancient poems, and having private conversation with the robots. The satisfaction of each function was measured on the Likert scale, with scores ranging from 1 as "very dissatisfied" to 5 as "very satisfied".

In addition, we included child, parent, and family characteristics as control variables. Child characteristics included *age*, *gender*, *grade* (1st or 2nd), and *hours of electronic use*. Considering the relevance of electronic device usage on child development, we asked, "On a usual day, about how much time do you spend with computers, cell phones, handheld video games, TV, and other electronic devices, doing things other than schoolwork?" Parent and family characteristics included parent marital status, caretaker's identity and health, and family location. Caretaker identity included mother, father, grandparent, and others. Caretaker's health status contained four categories: good health represented that the caretaker did not have disease and was able to work and live independently; fair health designated that the caretaker had disease but was able to work and live independently; poor health indicated that the caretaker was unable to work but lived independently. The last category was for caretakers who had some disability and were unable to live independently. Only 1% of the sample fell into this latter category, so we combined this category with the "poor health" category. Family location indicated the residence of the family in either Sichuan or Hunan province.

Analytic Strategy

Our analyses began with a descriptive analysis of sample characteristics. Ordinary least squares (OLS) regression was then performed to assess the net effect of robot use on life quality, controlling for all other variables. We first regressed the PedsQL score on usage of the robots and other characteristics. We then regressed each subscale of PedsQL on the independent variables. Finally, we ran regression on the use and satisfaction of functions of the robots on the PedsQL and subscale scores to test the robustness of the results.

Results

Descriptive Results

Table 1 presents the descriptive results of the sample. The average PedsQL score was 80.7, with a standard deviation of 11.8, suggesting that some of children had poor life quality while overall were good. Among the subscales of life quality, children scored low on physical and emotional functioning, but tended to have higher scores for social and school functioning. Overall, about 93% of the sample used the Xiao En Intelligent Robots. The average time of use was 1.3 hours. A majority of the children, 71%, used the robots for less than 1 hour.

The average age of the children was 7.3 years old, with a standard deviation of 0.7. About 56% of the sample were female. About 51% were first-grade student. In terms of other electronic device usage, the average usage time was 1.2, with a standard deviation of 0.7. For about 71% of the sample, their parents' marital status was married. This was followed by divorced parents (9.0%), separated parents (6.4%), and widowed parents (3.8%). About 10% of the children did not know their parents' marital status. The majority of the child caretakers were their grandparents (62%), followed by their mothers (31%), others (5%), and father (1%). Majority of caretakers had good or fair health, 64% and 24%, respectively, however, about 12% of them had poor health. About 56% of the sample lived in Sichuan province while the rest resided in Hunan province.

Table 2 lists the usage and satisfaction of robot functions. On average, children used singing, storytelling, reciting ancient poems, and private communication functions frequently, ranging from 93% to 99% using these functions. However, only 68% used the parent communication function. Regarding satisfaction of the functions, satisfaction scores were high for singing, storytelling, and reciting ancient poems, but scores for parent communication and private conservation were relatively low with particularly large standard deviations.

Regression Results

Table 3 presents the OLS regression results of the PedsQL score. Three models were presented. The first model tested the usage of the robots as a dummy variable, yes or no, while the second one examined the linear effect of the robots by measuring the usage in hours. The third model specifies the usage of the robots as categories: no use, less than 1 hour, 1-2 hours, and 2 hours and more.

Notably, use of robots showed strong effects on the PedsQL score in model 1. Controlling for all other variables, children who used the robots were associated with scores 11.6 points higher than those of children who did not use the robots. In addition, caretaker's health, gender, and family location all affected the PedsQL score. Compared to children whose caretakers with good health, children whose caretakers with poor health had scores that were 9.1 points lower. Boys tended to have scores that were 4 points lower than those of the girls. Children who lived in Hunan had scores 6.3 points higher than children from Sichuan. Hours on other electronics and parents' marital status reached marginal significance. Increasing one hour of use on other electronics was associated with PedsQL scores that were 2.6 points lower. Compared to children with married parents, children with separated parents had 6.8 points less on their PedsQL score. The adjusted R-squared value was 0.14 for the model.

Turning to the results of models 2 and 3, robot usage continued to show strong and positive effects on the PedsQL score. Increasing one hour of robot use was associated with an increase of 4.6 points in the PedsQL score (see model 2). In model 3, compared to children who did not use the robots, children used the robots for less than 1 hour had scores 9.8 points higher. The effects increased to 11.5 and 18.1 points for children using 1-2 hours and 2 hours and more, respectively. As for other variables, the estimated coefficients in model 2 and 3 were similar to the ones in model 1 although differences do exist. For example, estimates of hours on electronic use increased from -2.6 in model 1 to -2.7 in model 2, and to -3.0 in model 3 and achieved 5 percent significance level. Children with caretakers in fair health also showed lower PedsQL scores than children whose caretakers were in good health (see models 2 and 3). The adjusted R-squared value for models 2 and 3 were both at 0.18.

Table 4 presents the OLS regression results of the PedsQL subscale scores. The model follows the structure of model 2 from Table 3. For simplicity, we only listed the results of the key variables that we focused on in this study. We also ran the regression based on model 3 of Table 3, and the results were similar to the ones presented here. Hours of robot use showed strong and consistent effects on child quality of life: usage significantly increased levels of physical, emotional, and school functioning and marginally advanced social functioning. For example, an increase of one hour in robot use was associated with a 6.3-point increase in physical functioning; a 4-point increase in emotional functioning; a 3.9-point increase in school functioning; and a 3.2-point increase in social functioning. In contrast, time spent on other electronic appears to have negative effects on physical functioning. Specifically, one hour of other electronic use was associated with a physical functioning score of 5.2 points less. The effects of other electronic use on emotional, social, and school functioning were not significant. As for the health of caretakers, the effects of caretaker health on child emotional and school functioning were significant. Compared to children whose caretakers were in good health, children whose caretakers were in fair health had emotional functioning scores that were 8.2 points lower. Those with caretakers who were in poor health had scores that were 9.3 points lower. Likewise, for school functioning, estimates were 5.6 and 13.4 points lower for children whose caretakers were in fair and poor health, respectively. We also found that children whose caretakers were in poor health were marginally associated with lower physical and social functioning, 6.7 and 7.8 points lower, respectively.

Lastly, Table 5 presents the estimates of usage of and satisfaction with the robot functions on the PedsQL and subscale scores. For robot use, the analyses were limited to 145 cases.

There are five specifications. Each specification includes all the variables listed in model 2 of Table 3, along with the use of and satisfaction with each function detailed under the specification. Use of and satisfaction with the private conversation, storytelling, and singing functions all show strong effects on the PedsQL and subscale scores. Specifically, using private conversation was associated with a 9.2-point higher PedsQL score: with an 11-point increase in physical functioning and a 17.5-point increase on social functioning. Meanwhile satisfaction with private conversation was associated with a PedsQL score that was 2.4 points higher: a 2.5-point increase in physical functioning; a 3.1-point increase in emotional functioning; and a 2.8-point increase in school functioning. Likewise, the use of storytelling was associated with a score of 10.7 points higher: physical functioning increased by 11.2 points and emotional functioning increased by 15.7. Satisfaction with storytelling was associated with a score that was 2.2 points higher: there was a 2.9-point increase in physical functioning and a 3.2-point increase in school functioning. The satisfaction with the robot's singing function was associated with a +3.1 points difference in the PedsQL score, with a physical functioning score 2.6 points higher; an emotional functioning score 3 points higher; social functioning score 2.9 points higher; and, finally, a school functioning score that was 4.3 points higher. The use of the singing function did not have strong effects on the PedsQL and subscale scores. In specification 1 and 3, we did not find that the use of nor satisfaction with the functions of parent communication and reciting ancient poems had effects on the PedsQL and subscale scores.

Discussion and Conclusion

Given lack of access to educational and care resources in rural communities, an innovative approach is required to compensate for the gap between the overall quality of life between rural and urban children. The Xiao En Intelligent Robots project by the Ensan Charity Foundation intends to serve as that alternative method of providing the proper educational and care to rural children.

The results of this study indicate that rural children, in general, have fair life quality as measured by the PedsQL score. Some have low life quality scores, particularly when focusing on the subscales for physical and emotional functioning. Children frequently used the Xiao En Intelligent Robots. On average, the children spent 1.3 hours daily on the robots; use of the singing, storytelling, reciting ancient poems, and private conversation functions were high, all over 90%. Surprisingly, the use of parent communication was low: 68% of the children used it. A further investigation showed that a lot of children resided in rural areas where the internet signal was weak or even unavailable, thus deterring their use of the function. Likewise, weak connection or lack of internet may also affect the satisfaction of parent communication and private conversation.

Use of and satisfaction with the robots appear to have strong and positive effects on life quality. It is noteworthy to point out that duration of robot use had a positive effect on life quality, while time spent on other electronics had a negative effect on life quality. The results suggest that we can potentially replace negative electronic usage with time spent on high-quality and educational devices. The results further indicate that both usage of and satisfaction with the functions of private conversation, storytelling, and singing advanced child life quality across various dimensions, including physical, emotional, social, and school functioning. In contrast, reciting ancient poems and parent communication had no effect on life quality. The findings indicate that the content of each function must be fitted to the daily life of children. The functions must also appeal to children's interests. As for parent communication, a further investigation showed that the messages left for parents or children often left unreceived, probably due to weak internet signal or parents' busy work schedule. Thus, a vital next step for the Xian En Intelligent Robots project is the strengthening of the parent communication function in order to more improve upon its usage and satisfaction among parents and children alike.

Our findings provide important policy and practical implications. Although there may be skepticism surrounding the ability of Xiao En Intelligent Robots to adequately care for rural children in place of other guardians, the findings in this study provide empirical evidence to support that Intelligent Robots may provide an alternative approach to resolve the lack of care and educational resources for rural children. If the Intelligent Robots solution was coupled with a mentorship/sibling program, the combination of real and virtual support could further advance the quality of life for these children. With respect to practical implications, the findings of this study provide avenues for the Xiao En Intelligent Robots project to improve upon certain functions of the robots, particularly communication with parents and private conversation capabilities. The next key challenges that Xiao En Intelligent Robots should seek to address are: the weak internet connection in rural areas; conversation quality between the robots and users; and logistics to strengthen and improve parent-child interaction via the robot platform.

Although our findings yielded strong results and a promising approach to narrowing the gap between were limited to few rural areas. In future studies, a larger and randomly selected sample size from various randomly selected areas could validate our results further, as well as yield more reliable relationships among the robots and quality of life subscale measures of rural children. Second, while our cross-sectional design has validated the significant relationship between the use of the robots and child life quality, future studies can use longitudinal data to establish causality and further examine possible mediation effects. Finally, future studies may consider how different kinds of content being viewed, accessed, or engaged with may also have an effect on life quality and beyond.

Table 1. Descriptive statistics of sample characteristics

	Mean (S.D.)
PedsQL [0-100]	80.7 (11.8)
Physical Functioning [0-100]	77.1 (15.5)
Emotional Functioning [0-100]	78.7 (17.1)
Social Functioning [0-100]	87.0 (16.0)
School Functioning [0-100]	82.2 (16.0)
Use of Robot [%]	
No	7.1
Yes	92.9
Hours on Robot Use	1.3 (0.8)
No Use [%]	7.1
< 1 Hour [%]	70.5
1-2 hour [%]	10.9
2 hours and more [%]	11.5
Age	7.3 (0.7)
Gender [%]	
Male	43.6
Female	56.4
Grade [%]	
First	51.3
Second	48.7
Hours on Electronic Use	1.2 (0.7)
Parent Marital Status [%]	
Married	70.5
Separated	6.4
Divorced	9.0
Widowed	3.8
Unknown	10.3
Caretaker [%]	
Mother	30.8
Father	1.3
Grandparent	62.8
Others	5.1
Caretake Health [%]	
Good	64.1

Fair	24.4
Poor	11.5
Location [%]	
Sichuan	55.8
Hunan	44.2

N=156. Figures in table are means or percentages, with standard deviations in parentheses.

Table 2: Use and Satisfaction of the Xiao En Intelligent Robots

	Mean (S.D.)
Use of Functions [%]	
Parent Communication	68.3
Singing	98.6
Storytelling	96.7
Reciting Ancient Poems	93.8
Private Conversation	93.1
Satisfaction of Functions [1-5]	
Parent Communication	4.2 (1.0)
Singing	4.6 (0.8)
Storytelling	4.5 (0.9)
Reciting Ancient Poems	4.6 (0.8)
Private Conversation	4.3 (1.1)

N=145. Figures in table are means or percentages, with standard deviations in parentheses.

Table 3. Regression analysis of Life Quality

	Model 1			Model 2			Model 3		
	B	**S. E.**	**P**	**B**	**S. E.**	**P**	**B**	**S. E.**	**P**
Use of Robot	11.57	3.90	**	---	---		---	---	
Hours on Robot Use	---	---		4.61	1.18	***	---	---	
No Use	---	---		---	---		---	---	
< 1 Hour	---	---		---	---		9.80	3.87	*
1-2 hour	---	---		---	---		11.46	4.63	*
2 hours and more	---	---		---	---		18.11	4.45	***
Hours on Electronic Use	-2.59	1.43	+	-2.71	1.40	+	-2.96	1.41	*
Age	-1.43	1.67		-1.62	1.63		-1.69	1.63	
Boy	-3.86	1.89	*	-3.89	1.85	*	-3.78	1.85	*
2nd Grade	2.16	2.55		2.93	2.49		2.52	2.50	
Separated	-6.82	3.75	+	-6.09	3.67		-6.55	3.67	+
Divorced	-4.59	3.33		-2.64	3.28		-3.35	3.30	
Widowed	-5.92	5.07		-7.00	4.89		-6.45	5.01	
Marital Unknown	1.33	3.08		3.57	3.01		2.80	3.06	
Caretaker, Father	-9.83	8.54		-9.59	8.35		-8.83	8.51	
Caretaker, Grandparent	1.64	2.21		2.18	2.14		2.02	2.20	
Caretaker, Other	-2.14	4.10		-1.64	4.02		-1.36	4.05	
Caretaker, Health, fair	-3.61	2.26		-4.34	2.22	+	-4.65	2.26	*
Caretaker, Health, poor	-9.12	3.11	**	-8.96	3.04	**	-9.39	3.07	**
Location, Hunan	6.33	2.30	**	5.39	2.19	*	6.20	2.25	**
Constant	83.50	11.99	***	89.36	11.44	***	85.96	11.75	***
R-square	0.14			0.18			0.18		

Note: N=156. * p < .05, ** p <.01, *** p < .001.

Table 4. Regression Analysis of Life Quality Subscales

	Physical			Emotional			Social			School		
	B	S. E.	P	B	S. E.	P	B	S. E.	P	B	S. E.	P
Hours on Robot Use	6.33	1.57	***	3.96	1.77	*	3.20	1.73	+	3.90	1.71	*
Hours on Electronic Use	-5.20	1.86	**	-1.51	2.10		-1.97	2.06		-0.66	2.02	
Caretaker, Health, fair	-3.58	2.94		-8.24	3.33	*	-0.35	3.26		-5.63	3.21	+
Caretaker, Health, poor	-6.71	4.03	+	-9.27	4.55	*	-7.84	4.46	+	-13.37	4.39	**

Note: N=156. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 5. Regression Analysis of PedsQL by Robot Functions

	PedsQL			Physical			Emotional			Social			School		
	B	**S. E.**	**P**	**B**	**S. E.**	**P**	**B**	**S. E.**	**P**	**B**	**S. E.**	**P**	**B**	**S. E.**	**P**
Specification 1															
Use of Parent Communication	-1.33	2.37		-2.60	3.00		-1.76	3.62		3.73	3.55		-3.92	3.45	
Satisfaction of Parent Communication	1.38	1.01		1.86	1.28		0.65	1.55		1.07	1.51		1.64	1.47	
Specification 2															
Use of Singing	-3.85	8.99		11.18	11.60		-16.65	13.87		-11.36	13.71		-7.58	13.14	
Satisfaction of Singing	3.13	1.09	**	2.58	1.41	+	3.02	1.69	+	2.91	1.67	+	4.34	1.60	**
Specification 3															
Use of Storytelling	10.74	4.84	*	11.20	6.17	+	15.68	7.48	*	11.36	7.46		4.46	7.18	
Satisfaction of Storytelling	2.16	0.98	*	2.89	1.25	*	1.72	1.51		0.37	1.51		3.23	1.45	*
Specification 4															
Use of Reciting Ancient Poems	4.23	3.85		2.57	4.98		3.76	5.97		4.19	6.01		5.41	5.69	
Satisfaction of Reciting Ancient Poems	1.84	1.13		2.04	1.47		2.81	1.70		0.82	1.77		2.67	1.67	
Specification 5															
Use of Private Conversation	9.20	3.46	**	11.00	3.36	*	4.70	5.44		17.56	5.25	**	2.43	5.23	
Satisfaction of Private Conversation	2.40	0.81	**	2.47	1.05	*	3.09	1.28	*	1.17	1.23		2.84	1.23	*

Note: N=156. * $p < .05$, ** $p < .01$, *** $p < .001$.

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