

## Gross motor and language developmental stimulation via play during sitting attainment in orphaned infants

Sunanta Prommin<sup>1</sup>, Surussawadi Bennett<sup>1</sup>, Ponlapat Yonglitthipagon<sup>2</sup>, Lugkana Mato<sup>2</sup>, Michael John Bennett<sup>3,4</sup>, Wantana Siritaratiwat<sup>1\*</sup>

<sup>1</sup> Research Center in Back, Neck, Other Joint Pain and Human Performance (BNOJPH), Faculty of Associated Medical Sciences, Khon Kaen University, Khon Kaen, Thailand.

<sup>2</sup> School of Physical Therapy, Faculty of Associated Medical Sciences, Khon Kaen University, Khon Kaen, Thailand.

<sup>3</sup> University Hospital Southampton NHS Foundation Trust, Southampton, United Kingdom.

<sup>4</sup> Faculty of Medicine, University of Southampton, Southampton, United Kingdom.

### KEYWORDS

Independent sitting;  
Orphaned infants;  
Alberta Infant  
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### ABSTRACT

Orphaned infants often show delayed language development due to their limited child-rearing practices. The stimulation of language development before the attainment of sitting is questionable. The aim was to compare the scores of language and gross motor development before and after one-month stimulation program. Two groups of 20 healthy full-term orphaned infants aged 6-9 months were recruited for this quasi-experimental study. The first group consisted of infants who sat with support, and the second group consisted of those who sat independently. All infants received routine care and a program of substitutional 45-minute structured play three days per week for four weeks. The gross motor development of infants was directly observed using the Alberta Infant Motor Scale, and language development was assessed using the Communication and Symbolic Behaviors Scales-Developmental Profile Infant-Toddler Checklist at the pre- and post-four-week stimulation program. The differences in outcomes before and after intervention were examined using the paired t-test and the Wilcoxon signed-rank test. There were no significant differences in the means of language scores before and after four-week stimulation programs in both groups of infants, while both groups exhibited significant differences in gross motor development. Therefore, the stimulation program via play while attaining sitting skills may enhance language development in orphaned infants.

\*Corresponding author: Wantana Siritaratiwat, PT, PhD. Research Center in Back, Neck, Other Joint Pain and Human Performance (BNOJPH), Faculty of Associated Medical Sciences, Khon Kaen University, Khon Kaen, Thailand. Email address: wantana@kku.ac.th  
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## Introduction

Orphaned infants, compared to home-raised infants, are not exposed to diverse nurturing environments. As a consequence of the caretakers' high workload and the child-rearing environment in orphanages, child care institutions appear limited in infants' daily activity and human interaction. Infants in orphanages are frequently raised in confined spaces or spend most of their time in cots due to insufficient caregivers and precautions put in place to prevent potential accidents among infants. Infants in this environment are prone to having little chance of contact with diverse movement experiences or to interact with various objects in daily living. A previous longitudinal study demonstrated that orphanage-raised 6-9-month-old infants displayed narrow intra-individual variability in gross motor development<sup>(1)</sup>. These orphaned infants also showed their gross motor percentiles below the 50<sup>th</sup> percentile via series assessments<sup>(1,2)</sup>. Several pieces of evidence also indicated that infants raised in orphanages exhibited delayed development in at least one domain, such as gross motor or language development<sup>(3-5)</sup>. Previous cross-sectional studies reported deficits in gross motor skills<sup>(3,4)</sup>, especially sitting and standing, languages<sup>(3)</sup>, and cognitive development<sup>(5)</sup> in orphanage-raised infants.

The acquisition of gross motor skills, such as sitting, crawling, and pulling to stand, is clearly noticeable between the ages of six and nine months in healthy, typically developing infants. An independent sitting ability, in which infants can control the head and various segments of the trunk<sup>(6,7)</sup>, is a crucial developmental milestone. According to a WHO multicenter study, typically developing infants exhibit an ability to sit without support within a wide range of age before the first year of life<sup>(8)</sup>. In addition, the ability to sit also enables infants to perform independent reaching and interact with objects around them<sup>(9)</sup>.

In relation to objects and child-rearing contexts during the second half of the first year of gross motor skill acquisition, infants develop a basis of language acquisition and communication abilities<sup>(10)</sup>. Previous studies have shown that language and motor skills are closely interrelated in development. There are correlations between gross motor skills, especially sitting<sup>(7,11)</sup>, and language development in healthy typically developing infants. Libertus and Violi<sup>(7)</sup> found that the emergence of sitting skills is a significant predictor of subsequent language development in healthy developing infants. The cross-sectional studies found correlations between gross motor skills and language development in infants aged between three months and three years<sup>(12,13)</sup>. It has been suggested that motor scores were significantly related to receptive, expressive vocabulary or language development when oral movement, gross motor score, gesture, and symbolic function are taken into account. In addition, infant receptive and productive vocabularies were increased when they were exposed to functional locomotor activity<sup>(14)</sup>. Infants in the age of learning to sit also demonstrate chattering, which is a part of language development<sup>(15)</sup>. Typically developing infants also showed a significant relationship between motor and language development, as early as 6 to 12 months. The ability to lift the chest with arm support at six months was found to be positively correlated with turning toward sound<sup>(16)</sup>.

The beginning of language development stimulation in children with delayed language development clinically starts when they are able to sit independently. Given the significant relationship between gross motor and language development, language skills could be simultaneously developed at around the age of sitting attainment<sup>(12,13,16)</sup>. The stimulation of language development in orphaned infants when infants are still sitting with support is a topic of interest in the current study. Our study questioned whether language development could be improved

through play programs administered to infants who sat with support<sup>(15,16)</sup>. Furthermore, data regarding developmental stimulation in language development in orphaned infants, particularly during the period of sitting skill acquisition, is limited. We hypothesized that through one-month structured play during sitting attainment, healthy orphaned infants would exhibit enhanced language and gross motor development. The reason why a four-week period was chosen to measure the outcomes after intervention, as it is enough to observe changes in gross motor development<sup>(17)</sup>, nevertheless, there was no data supporting the amount of time needed for language stimulation in young orphaned infants. Therefore, this study aimed to compare the scores of language and gross motor development of healthy orphaned infants before and after a four-week stimulation program. Comparisons between pre- and post-intervention were performed in two groups of infants: those who sat with support and those who sat independently.

## Materials and methods

### *Study design and description of the orphanage setting*

The current quasi-experimental study was conducted in healthy full-term orphanage-raised infants. Routine care was provided by caregivers with more than 10 years of experience in orphanage care for infants aged from birth to one year. Infants live in one room located in a two-story building. The ratio of caregivers to infants is 1 caregiver to 7-10 infants. All caregivers are female, with an average age of 45 years. The routine stimulating care consists of a five-minute massage session after a morning bath and free play on the floor for 45 minutes, once or twice each day on weekdays, depending on the availability of caregivers. In addition to bottle feeding, infants receive regular baths once or twice a day, diaper changes as needed, and meal feedings at lunch and dinner.

### *Participants*

From a registry of orphaned infants, 6- to 9-month-old healthy infants with a gestational age of more than 37 weeks were conveniently recruited. Infants were excluded if they presented with the following criteria: 1) major neurological abnormalities, such as muscle paralysis, jerky movements, and seizures; 2) genetic diseases, such as Down's syndrome; 3) congenital diseases, such as heart disease and musculoskeletal disorders; and 4) deficits in vision or hearing, as well as issues affecting motor development. The first group contained infants who sat with support, and the second group had those who sat independently. In this study, the definition of "sat independently" was defined as infants demonstrating a sitting posture and achieving the score on the sitting picture of item no. 9 of the Alberta Infant Motor Scale (AIMS)<sup>(18)</sup>. This is observed as an infant in a sitting posture displaying the act of reaching for a toy and trunk rotation with ease. While infants who sat with support means those who cannot sit by themselves or could not attain the score on the sitting picture of item no. 9 of the AIMS<sup>(18)</sup>.

### *Ethical clearance*

The study protocol was approved by the Ethics Committee in Human Research at Khon Kaen University based on the Declaration of Helsinki and the ICH Good Clinical Practice Guideline (Institutional Review Board Number: IRB00008614, Protocol ID No: HE622234, 04/12/2019). The guardian of the orphanage signed an informed consent form authorizing data collection at the orphanage and the voluntary participation of staff and infants. Data collection occurred between December 2019 and September 2021. The researcher scheduled data collection visits after the head of the orphanage and staff had given their informed consent to participate voluntarily and to allow their infants to be assessed for gross motor and language development. The data were anonymized so as not to disclose the identities of the participants,

and the analyses were conducted so that the final results could not be traced back to specific individuals.

### ***Experimental procedure***

The following participant characteristics were recorded: gender, birth weight, birth height, head circumference, gestational age, Apgar score at five minutes, and age upon admission to the orphanage. Infants were initially recruited between the ages of six and nine months, and the first data collection commenced 15 days after recruitment. Each infant was assessed twice, prior to and after a post-one-month intervention.

### ***Interventions***

#### ***A 45-minute structured play for infants who sat with support***

Infants received a substitutional program of 45-minute structured play, which was modified from a previous study<sup>(19)</sup>, three days per week for four weeks by pediatric physiotherapists who had over five years of expertise working with orphaned infants. The 45-minute structured program included a 30-minute play session in an upright posture and a 15-minute free-movement session on the floor. The 30-minute play consisted of 20 minutes playing with toys while sitting or standing with pelvic support and a 10-minute seated session listening to a storybook, singing a song, clapping hands, and enjoying peek-a-boo. Throughout the 15-minute period of free movement on the floor, infants were able to move in and out of various positions under supervision.

#### ***A 45-minute structured play for infants who sat independently***

Infants received a substitutional program of 45-minute structured play, which was modified from a previous study<sup>(19)</sup>, three days per week for four weeks by pediatric physiotherapists who had over five years of expertise working with orphaned infants. The 45-minute structured program included a 30-minute play session in an upright posture and a 15-minute free-movement session on the floor. The 30-minute play for infants

was 20 minutes of actively playing with the toys while sitting or cruising and a 10-minute session of standing and walking with support outside the building once a week, or 10 minutes of listening to a storybook, singing a song, clapping hands, and enjoying peek-a-boo twice a week. Throughout the 15-minute period of free movement on the floor, infants were able to move independently in and out of various positions, such as creeping, crawling, sitting, pulling to stand, and standing under supervision.

Toys were used to encourage physical movement in these sessions. Infants joined the stimulation program only when they were feeling well and cooperated, such that they could sit with support, hold heads in the midline, or stand with support and stand on their feet or with the variable movement of legs<sup>(18)</sup>. The play activities were terminated if the infant cried or showed distress.

### ***Outcome measures***

#### ***The Communication and Symbolic Behavior Scales-Developmental Profile (CSBS-DP) Infant-Toddler Checklist***

The CSBS-DP checklist is a parent- or caregiver-reported measure of infants and toddlers aged 6 to 24 months' communicative and symbolic abilities<sup>(20)</sup>. The observation can be performed on three composites of language development, including social communication, speech (sound and word use), and symbolic behaviors. The three composites contain 24 items, and each item could be scored with an ordinal scale of 0 points for "Not Yet," 1 point for "Sometimes," and 2 points for "Often." Items describing a series of numbers can be scored with 0 points for items checked "None" and 1-4 points for numbered choices. The total of CSBS-DP scale of 57 scores were added together from 26 of social scores, 14 of speech scores, and 17 of symbolic scores<sup>(20)</sup>. Raw scores of each composite and the total raw scores of language development were transferred to the standard scores using the Easy Score program (Infant-Toddler Checklist and Easy

Score©2002, Paul H. Brookes Publishing Co, Inc) <sup>(20)</sup>. Each composite contains standard scores of 17, and the total standard scores are 135.

The main primary caregiver, who was familiar with infants, performed a checklist of the early communication and behavioral development of each participant using the CSBS-DP<sup>(20)</sup>. The primary caregiver completed the behavioral checklist for each infant within 10 minutes. If the infant did not cooperate or other factors interfered, the assessor performed the test again within five days of the initial assessment. The therapist also monitored each child to eliminate over- or underestimation of the infants' language ability. The main caregiver was unaware of how each observation and checklist was scored. All tests' scoring was performed and double-checked by pediatric physical therapists.

#### *Alberta Infant Motor Scale (AIMS)*

The AIMS is a standardized norm-referenced observation, and the performance-based test commonly utilized in research to evaluate the spontaneous movement of infants from birth until the age of independent walking attainment<sup>(18)</sup>. The test measures components of postural control, antigravity movements, and body alignments, such as trunk rotation and weight shifting in different positions, including 21 items in the prone, 9 items in the supine, 12 items in the sitting, and 16 items in the standing positions. The total raw scores range from 0 to 58<sup>(18)</sup>.

The AIMS Thai version<sup>(21)</sup> was utilized to evaluate the gross motor development of each participant during the observation by a physical therapist with six years' experience in pediatric physical therapy. The assessor performed the observation in the orphanage's living room, where the infants were familiar with the environment and the main caregiver was present nearby. The observation time was approximately 20 minutes for each participant. To prevent bias, raw scores of gross motor development were totaled by

another researcher and the assessor did not know the scores until data collection was completed.

The intra-rater reliability performed by the physical therapist with one-month interval showed a high intraclass correlation coefficient (ICC) value (ICC (3,1) = 0.99, 95%CI = 0.98-0.99). This assessor practiced using the AIMS for six months before data collection, and the inter-rater reliability between the assessor and the expert, with more than 10 years of using the AIMS, using the ICC (3,1) was 0.98 (95%CI = 0.95-0.99).

#### *Statistical analysis*

All participants' demographic data were characterized by descriptive statistics. The normality of the data was analyzed using a Shapiro-Wilk test. Non-normally distributed data was analyzed using the Wilcoxon signed-rank test, while normal distributed data was analyzed using the paired t-test. The levels of effect size convention were analyzed and classified as < 0.49 = small, 0.50-0.79 = medium, and  $\geq 0.80$  = large<sup>(22)</sup>. SPSS version 17.0 for Windows (licensed by Khon Kaen University, Khon Kaen, Thailand) was used to perform the data analyses, with a significance level of  $p$ -value < 0.05.

## **Results**

According to the birth characteristics presented in table 1, all participants in this study were healthy, with full-term births. They had been admitted to the orphanage at a minimum age of 10 days. The mean  $\pm$  SD age of infants who sat with support at recruitment was  $7.1 \pm 0.7$  months, and their mean sitting score was  $5.9 \pm 2.7$  points. Infants who sat independently had a mean  $\pm$  SD age at recruitment of  $8.2 \pm 0.7$  months, with a mean sitting score of  $10.5 \pm 2.2$  of a total of 12 points. There were 12 boys in the "sat with support" group and 14 boys in the "sat independently" group.

Table 1 Participants' characteristics

Birth characteristic	Sat with support group (n = 20)	Sat independently group (n = 20)
Birth weight (g)	2717.7 ± 223.9	2756.1 ± 229.4
Birth height (cm)	49.5 ± 3.0 <sup>a</sup>	47.8 ± 2.1 <sup>b</sup>
Birth head circumference (cm)	31.8 ± 1.3 <sup>a</sup>	31.6 ± 1.3 <sup>b</sup>
Gestational age (weeks)	38.2 ± 0.6	37.8 ± 0.9
Apgar score at 5 minutes	9.1 ± 0.6 <sup>a</sup>	9.3 ± 0.5 <sup>b</sup>
Age at admission in the orphanage (days)	54.6 ± 43.1	79.8 ± 47.0

**Note:** Data was presented with mean ± SD. <sup>a</sup>No information on birth height, birth head circumference of 3 infants, and Apgar score of 5 infants in sitting with support group. <sup>b</sup>No information on birth height, birth head circumference of 3 infants, and Apgar score of 5 infants in the sat independently group.

Table 2 shows that language scores obtained from the CSBS-DP were slightly increased in both groups of participants after a four-week stimulation program. However, there were no significant differences in the mean ± SD of language scores before and after the stimulation program in both groups of infants. In analyses of the sub-composite of language development, there were no significant differences in any composite of language skills before and after the one-month intervention for both groups of infants.

Gross motor scores, obtained using AIMS, of infants in both groups differed significantly before and after the stimulation program ( $p$ -value = 0.001), with a large effect size: 1.01 for infants who sat independently and 1.61 for infants who sat with support. Infants in the sat with support group displayed significantly increased scores in all sub-scales of gross motor development, while infants who sat independently showed significant improvement in prone and standing sub-scales.

**Table 2** Mean  $\pm$  SD of the CSBS-DP and AIMS scores of infants who sat with support (n = 20) and those who sat independently (n = 20) before and after the stimulation program

Development	Sat with support group (n = 20)				Sat independently group (n = 20)					
	Before	After	Difference	p-value	Effect size (d <sub>cohen</sub> )	Before	After	Difference	p-value	Effect size (d <sub>cohen</sub> )
CSBS-DP scores	84.8 $\pm$ 12.1	86.2 $\pm$ 15.6	1.45 $\pm$ 12.5	0.587	0.10	84.2 $\pm$ 13.8	86.6 $\pm$ 16.2	2.4 $\pm$ 12.3	0.354	0.16
- Social	10.2 $\pm$ 2.8	10.1 $\pm$ 2.9	-0.1 $\pm$ 2.7	0.714	0.01	9.85 $\pm$ 2.7	9.8 $\pm$ 3.1	0 $\pm$ 2.6	0.979	0.02
- Speech	6.8 $\pm$ 2.2	6.8 $\pm$ 2.7	0 $\pm$ 2.6	0.909	#	6.75 $\pm$ 2.6	7.0 $\pm$ 2.9	0.2 $\pm$ 3.0	0.908	0.09
- Symbolic	4.3 $\pm$ 0.9	5.2 $\pm$ 2.2	0.9 $\pm$ 2.3	0.128	0.54	4.5 $\pm$ 1.1	5.5 $\pm$ 2.6	0.9 $\pm$ 2.1	0.072	0.50
AIMS scores	29.4 $\pm$ 4.6	39.2 $\pm$ 7.3	9.9 $\pm$ 5.5	0.001**	1.61	40.4 $\pm$ 7.5	47.4 $\pm$ 6.3	7.2 $\pm$ 3.4	0.001**	1.01
- Supine	8.4 $\pm$ 0.5	9.0 $\pm$ 0.2	0.6 $\pm$ 0.5	0.001**	1.58	9.0 $\pm$ 0.0	9.0 $\pm$ 0.0	0.0 $\pm$ 0.0	#	#
- Prone	12.8 $\pm$ 2.1	15.6 $\pm$ 2.2	2.8 $\pm$ 1.8	0.001**	1.30	16.2 $\pm$ 1.8	19.3 $\pm$ 2.3	3.1 $\pm$ 2.1	0.001**	1.50
- Sitting	5.9 $\pm$ 2.7	9.6 $\pm$ 2.7	3.7 $\pm$ 2.6	0.001**	1.37	10.5 $\pm$ 2.2	11.7 $\pm$ 0.7	1.2 $\pm$ 2.0	0.051	0.74
- Standing	2.7 $\pm$ 1.8	5.2 $\pm$ 2.9	2.5 $\pm$ 2.5	0.002**	1.04	5.9 $\pm$ 2.7	8.8 $\pm$ 2.8	2.9 $\pm$ 2.2	0.008**	1.05

**Note:** CSBS-DP, The Communication and Symbolic Behavior Scales-Developmental Profile Infant Toddler Checklist; AIMS, Alberta Infant Motor Scale. Total raw scores of the AIMS = 58 scores, supine 9 scores, prone 21 scores, sitting 12 scores, and standing 16 scores. Total standard scores of the CSBS-DP = 135 scores, and each composite = 17 scores. The Wilcoxon signed-rank test was used to analyze the CSBS-DP scores of both groups and the AIMS of the sat independently group, while the paired t-test was used to analyze the AIMS scores of the sat with support group. # Significant difference (p-value < 0.05); \*\* Significant difference (p-value < 0.01) # data could not be analyzed due to the same value of mean.

## Discussion

The objective of the current study was to compare the language and gross motor scores before and after stimulation programs in infants who sat with support and in infants who sat independently. Results from the table 2 of our study did not support the hypothesis that through gross motor developmental stimulation in upright structured play during sitting skill attainment, healthy orphaned infants would exhibit simultaneous improvement in language development scores during the attainment of sitting skills.

The non-significant improvement in language development suggested that through structured play stimulation, their language skills could be independently developed. It could need more than 4 weeks for language skills to be stimulated. Although research evidence has found significant relationships between language and gross motor development<sup>(7,11,14,15,16)</sup>, Darrah et al<sup>(23)</sup> found that the acquisition of each developmental domain is independent in rate of development. Another reason for a non-significant difference of language scores could be an inadequate sample size of participants leading to a small power of test, approximately 8-10% of both groups.

According to a number of studies<sup>(24,25)</sup>, infants aged from 6 months up to the end of their first year were able to attain new skills related to being upright, such as crawling, sitting, pulling to stand, cruising, and finally walking independently. At this age range, a child is able to independently control the lower body and pelvis in conjunction with the development of upper trunk or upper chest motor skills<sup>(18)</sup>. After a four-week period of the stimulation program, both groups of infants in the orphanage recruited in this study displayed typically developing gross motor skills, especially independent sitting, according to the range of age from the WHO study<sup>(8)</sup>. From table 2, infants who were recruited when they sat with support significantly improved in all sub-scale scores of gross motor development measured using the AIMS, while infants who sat independently continued to

significantly achieve their gross motor scores in prone and standing positions. The non-significant increase in scores in the supine and sitting positions in this group could come from the ceiling effect of the AIMS measurement.

For children in orphanages who tend to have language developmental delay<sup>(3,5)</sup>, we support the concept of stimulating development that there is no need to wait until infants are able to sit independently before their language skills are stimulated. It is implied that the stimulation of language skills can begin when infants are able to control their head, neck, and upper trunk in an upright posture or in a pelvic-support seated posture. A previous study<sup>(26)</sup> suggests that the onset of unsupported sitting initiates a period of exploration and change in infant vocalization. When infants are first able to maintain an upright sitting position, they “discover” new possibilities for vocal production in the very act of vocalizing<sup>(26)</sup>.

Furthermore, the period of learning to sit independently may be critical to promote an optimal environment that is conducive to language development. Postural control development, especially in sitting, is important for motor milestones. Greco et al<sup>(27)</sup> mentioned that infants at the age of six to seven months display trunk control by modifying direction-specific adjustments to suit the situation at the thoracic level. It is suggested that once an infant has begun to babble, providing infants with trunk control in sitting would create the context for improving language skills<sup>(27)</sup>. In addition, improvement of trunk control in the sitting sub-scale could help attain visual capacity and acts as a composition of input and perception in part of language and cognition<sup>(26)</sup>.

The hypothesis of this study was not verified, and the current study contains several limitations. Infants were recruited conveniently from an orphanage located in the northeastern part of the country. The sample size was small which contained low power of test of the findings. It is suggested that in order to investigate the

effect of a stimulation program of structured play in upright positions, a larger sample size with a design of a randomized control trial is needed. The stimulation program, especially for language development, could be performed for a longer period. The fact that the study examined the outcomes after the four-week intervention was another limitation for the measurement of language development, future studies should consider a longer follow-up of gross motor and communication development until infants attain their development at the end of their first year of life.

## Conclusions

A stimulation program for language and gross motor development would be beneficial for healthy infants being raised in an orphanage, which could be started when infants still sat with support. This study found likely increased scores for language development after orphaned infants received the stimulation program during sitting attainment. The study suggests that the time before the onset of independent sitting or when infants are about to sit could be good for orphaned infants to promote their language and gross motor skills by providing more upright play and interaction with caregivers.

## Take home messages

Healthy orphaned infants showed non-significant improvement in language development through the a four-week gross motor stimulation program during the period of acquiring independent sitting skills. Nevertheless, infants who live in deprived environments should undergo language skill stimulation before they acquire independent sitting skills. A combination of stimulation programs for gross motor and language development should be implemented for infants raised in orphanages.

## Conflicts of interest

The authors declare no conflicts of interest.

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