Does infants' locomotive development affect parental awareness of pointing gestures by infants?

Takeshi Kishimoto（tkishimoto@u-sacred-heart.ac.jp）
〔University of the Sacred Heart〕

子どもの移動能力の発達は、親による子どもの指さしの気付きに影響するか？

岸本 健
聖心女子大学 文学部

要約

言語を操るようになる前である 11 ヵ月齢頃から、乳幼児は指さしを行うようになる。生後 2 年目になると、乳幼児の行う指さしの頻度が上昇することが知られている。この理由の 1 つは、乳幼児の姿勢運動能力が発達することによって、周囲にいる養育者が乳幼児の指さしに気付きやすくなり、乳幼児の指さしに対してより多く応答するようになるためかもしれない。これを検討するために、養育者による乳幼児の指さしの頻度の評定が、乳幼児の姿勢運動発達と関連しているかどうか調べた。158 名の養育者が、彼らの子どもによる指さしの頻度と姿勢運動発達に関する質問紙に回答した。分析の結果、乳幼児の月齢が 6 ヵ月齢から 17 ヵ月齢の間で、乳幼児の指さしの頻度に対する養育者の評定が上昇することがわかった。この時期には、乳幼児の姿勢運動能力の評定値も上昇していた。さらに、この時期において乳幼児の指さしの頻度に対する養育者の評定値は乳幼児の姿勢運動発達の評定値と正の相関関係にあり、この相関関係は乳幼児の月齢を統制しても変化しなかった。これら結果は、乳幼児の指さしの頻度に対する養育者の評定が、乳幼児の姿勢運動発達と関連していることを示している。この結果は、乳幼児の姿勢運動能力が発達するにしたがって、養育者が乳幼児の指さしに気付くようになり、その結果、乳幼児の指さしに対して頻繁に応答するようになる可能性を示唆している。

Key words

pointing gesture, infants, parents, locomotive development, parental awareness of infants' pointing gesture

1. Introduction

Before infants start speaking, they communicate with their caregivers by using pointing gestures. When pointing, the index finger and arm are extended in the direction of an interesting object, and the remaining fingers are curled under the hand, with the thumb held down and to the side (Butterworth, 2003). Some studies have shown that infants start pointing gestures at an average age of 11 months (Butterworth, 2003), while others have shown that infants begin using such gestures between the age of 8 to 15 months (Carpenter, Nagell, & Tomasello, 1998; Franco, 2005; Leung & Rheingold, 1981; Liszkowski & Tomasello, 2011). On the basis of these preceding studies, a distinction is often made between imperative pointing and declarative pointing. Infants use imperative pointing to use adults as a tool to obtain objects (Bates, Camaioni, & Volterra, 1975; Liszkowski, Carpenter, Striano, & Tomasselo, 2004). On the other hand, infants use declarative pointing to share their attention and interest in an object or event with adults (Liszkowski et al., 2004).

Some studies report that the frequency of the infants' pointing gestures becomes higher in their second year of life. Leung and Rheingold (1981) experimentally compared the frequency of pointing gestures by infants aged 10.6, 12.6, 14.5, and 16.8 months. They counted the number of times such gestures occurred in 10 minutes and showed that the mean frequency of the infants' pointing gestures significantly increased from 0.2 at 10.6 months to 4.6 at 12.6 months, 7.6 at 14.5 months, and 8.9 at 16.8 months. Blake, Osborne, Cabral, and Gluck (2003) longitudinally observed the interaction between infants and mothers at home every two weeks at varying ages between 9 and 14 months. They showed that the frequency of infants' pointing gestures at 14 months became 5 times as high as that at 10 months. These studies suggest that infants do not use pointing gestures at the beginning (e.g.,just before their first birthday), but they increase their usage of the gestures in the second year of their life.

This study examines the factors that promote the frequency of the usage of pointing gestures by infants. One of the probable factors is the development of infants' postural and locomotive patterns. During the first 18 months, infants acquire and refine a whole set of new postural and motor skills including sitting, standing by themselves, crawling, and walking (Iverson, 2010). Especially, standing by themselves or walking enable infants not to use their hands while supporting their weight. This means that the hands can be used to make gestures, including pointing (Clearfield, 2011; Iverson, 2010). Thus, at the very beginning, when infants begin to use pointing gestures, they would not be

able to make such gestures often because they would use their hands for movements such as crawling and supporting their weight. Contrastingly, in the second year of life, they would be able to make pointing gestures frequently because they become able to stand and walk by themselves, which would enable them to use their hands to make such gestures.

If, however, the infants' development of the locomotive pattern only shows a change in the use of their hands, the increase of the frequency of infants' pointing gesture in the second year of their life will not be evident. Hence, it may be concluded that the frequency of infants' pointing gestures rises and falls depending on their motivation to make pointing gestures. Liszkowski et al. (2004) investigated whether the reaction of the adult after the infants' pointing gesture affects the frequency of pointing gestures by infants. They found that infants at 12 months pointed most frequently if the adult actively shared his/her attention and interest in the event. In contrast, if the adult only looked to the event while ignoring the child, or only looked and emoted to the child while ignoring the event, or ignored both, infants pointed less frequently. This result suggests that infants are motivated to make pointing gestures more often if the adults around them are aware that they are making such gestures, and react appropriately. Thus, the increase of infants' pointing gestures in the second year of life would be caused not only by the changes in the pattern they use their hands, but also by the increase of awareness of such pointing gestures among the caregivers around them. From these inferences, it may be concluded that the infants' locomotive development perhaps changes not only the infants' use of hands, but also the adults' awareness about pointing gestures by infants.

This idea is supported by Vallotton (2009). In this study, the interaction between infants (aged between 4.9 and 11.6 months) and nursery staff was longitudinally observed. Vallotton found that as the infants grew older, their pointing gestures increasingly affected the nursery staff's responsiveness. Consequently, we may infer that the nursery staff was aware of the pointing gestures of older infants, whose locomotive pattern was more refined than that of younger infants, whose locomotive pattern was more rudimentary. However, Vallotton had not observed the infants' locomotive patterns, and it is possible that the nursery staff in her study did not respond to the pointing gestures by the older infants at a higher rate because they have more developed locomotive patterns.

Therefore, to demonstrate whether the development of infants' locomotive patterns affect the awareness among caregivers of infants' pointing gestures, we asked parents about the infants' locomotive patterns and the frequency of their pointing gestures within a recent week through a questionnaire. We hypothesized that if the infants' locomotive patterns affect the caregivers' awareness of the infants' pointing gestures, the parental reports of the frequency of such gestures will correlate with the infants' locomotive patterns, even if the age factor of the infants is considered to be constant.

2. Methods

2.1 Participants

The study was conducted with parents living around Tokyo, Japan. The questionnaires were distributed among at least 254 parents via two kindergartens and seven nursery schools. From among these questionnaires, 158 were returned (collection rate, 62.2 %). (1) The research was conducted with the fully informed permission of the Research Ethics Committee of the Department of Psychology, University of the Sacred Heart.

2.2 Participants used in this study

Among the potential participants, 29 participants were eliminated: 16 owing to incomplete forms, 2 because of incorrect descriptions, 5 because the infants were underaged for the study (i.e., under 6 months old), and 6 because the infants were overaged for the study (i.e., over 35 months). The final participants thus included 129 parents.

2.3 Measurements

In this study, we asked parents to answer the following questions about their youngest, or, where applicable, their only child.(2) Hereafter, we refer to the infants being studied as the target children. Among the target children, there were 78 boys and 51 girls. The mean age of the target children was 21.3 months (range: 6-35). In the study, we included children of various ages so that we can cover a range of age relatively large, and be able to identify the changing point when caregivers become aware of the pointing gesture of their target children.

(1) Dates when parents answered the questionnaire and birthdays of the target children
To know the correct ages (in months) of the target children, we asked parents the dates on which they answered the questionnaires and on which their children were born.

(2) Postural and motor developments of the target children
To ask parents about the postural and motor developments of their children, we used the method of measurement provided in Saijo (2004). By this procedure, the postural and motor developments of each target child were evaluated on a 12-point scale. The inferences obtained from each point were as follows: 1 (the child has not held his/her head up yet), 2 (the child has just started holding his/her head up), 3 (the child has been holding his/her head up), 4 (the child has been able to sit by himself/herself), 5 (the child has been able to move on his/her stomach), 6 (the child has been able to crawl on his/her hands and knees), 7 (the child has been able to crawl with his/her knees lifted off the ground), 8 (the child has been able to stand while holding on to something), 9 (the child has been able to stand by himself/herself for a second), 10 (the child has been standing by himself/herself adequately), 11 (the child has been

able to walk for a second), and 12 (the child has been able to walk adequately). The parents could choose all that applied to their target children. When we used this evaluation in the analysis, we adopted the highest number recorded as the score of the child's postural and locomotive developments.

(3) The frequency of imperative pointing by the target children
In order to examine how frequently the caregivers subjectively evaluated the target children's imperative pointing gestures, the parents were asked how often their children made pointing gestures to request them to retrieve what he/she wanted within a recent week. The frequency was evaluated using a 4-point scale: 1 (never), 2 (1 or 2 times per day), 3 (3 or 4 times per day), and 4 (5 or more times per day).

(4) The frequency of declarative pointing by the target children
In order to examine how frequently the caregivers subjectively evaluated the declarative pointing gestures by target children, the parents were asked how often their children made pointing gestures to communicate what interested them within a recent week. The frequency was evaluated using a 4-point scale: 1 (never), 2 (1 or 2 times per day), 3 (3 or 4 times per day), and 4 (5 or more times per day).

2.4 Data analysis

The participants were split into the following 5 groups based on the age of the target children: (a) parents whose infants (i.e., target children) were aged between 6 and 11 months (8 boys and 5 girls; M = 8.85 months); (b) those with target children aged between 12 and 17 months (17 boys and 16 girls; M = 14.76 months); (c) those with target children aged between 18 and 23 months (19 boys and 9 girls; M = 20.54 months); (d) those with target children aged between 24 and 29 months (21 boys and 14 girls; M = 27.06 months); (e) those with target children aged between 30 and 35 months (13 boys and 7 girls; M = 31.25 months).

Before beginning the main analysis, we combined the parental evaluations of the frequency of imperative pointing and declarative pointing of the target children through principal component analysis (PCA).[3] We then compared the principal component and the infants' locomotive patterns respectively among the five groups of participants by using ANOVA, to check whether the principal component and infants' locomotive development are operated simultaneously. Finally, we conducted Spearman's correlation analysis to investigate whether the principal component and infants' locomotive patterns were significantly correlated.

3. Results

3.1 Principal component analysis (PCA)

The unrotated solution of a PCA of the parental evaluations of the frequency of imperative and declarative pointing showed that a single principal component was extracted, which explained 92.5 % of the variance in the data (Table 1). This component was characterized by the parental evaluation of the frequency of pointing gestures by their target children in some context within a recent week, and thus was labeled "score of parental awareness of infant pointing."

Table 1: Results of Principal Component Analysis (PCA) of the Parental Evaluations of Imperative and Declarative Pointing Gestures by Infants

Pointing gestures evaluated by parents	Components 1
Imperative pointing	0.96
declarative pointing	0.96
Eigenvalue	1.85
% Total varance explained	92.54

Note: Unrotated component loading, eigenvalue, and percentage of total variance in the parental evaluation of the frequency of the pointing gestures by the target children by the component are shown.

3.2 Parental awareness of infant pointing and infants' postural and locomotive pattern among five groups of participants

A one-way ANOVA on mean score of parental awareness of infant pointing yielded a significant effect on the group of participants, F (4, 124) = 16.95, $p < 0.01$ (Figure 1). Post-hoc tests (Bonferroni's method) revealed that participants whose target children were aged between 6 and 11 months evaluated the frequency of the pointing gesture of their target children lower than those whose target children were aged between 12 and 17 months ($p < 0.01$), 18 and 23 months ($p < 0.01$), 24 and 29 months ($p < 0.01$), and 30 and 35 month ($p < 0.01$). There were no significant differences between the latter four groups of participants. Thus, the parental evaluation of the frequency of pointing gestures by infants became higher when their target

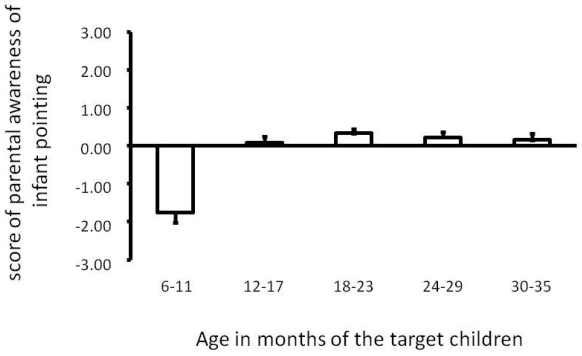

Figure 1: The mean scores of parental awareness of infant pointing in each group of participants. T-bars represent standard errors.

children were aged between 6 and 17 months.

A one-way ANOVA on mean score of infants' postural and locomotive scores yielded a significant effect on the group of participants, F (4, 124) = 20.11, $p < 0.01$ (Figure 2). Post-hoc tests (Bonferroni's method) revealed that participants whose target children were aged between 6 and 11 months evaluated their target children's development of postural and locomotive patterns lower than those whose target children were aged between 12 and 17 months ($p < 0.01$), 18 and 23 months ($p < 0.01$), 24 and 29 months ($p < 0.01$), and 30 and 35 months ($p < 0.01$). Furthermore, the participants whose target children were aged between 12 and 17 months evaluated their target children's development of the postural and locomotive patterns lower than those whose target children were aged between 18 and 23 months ($p < 0.01$), 24 and 29 months ($p < 0.01$), and 30 and 35 months ($p < 0.01$). There were no significant differences between the latter three groups of participants. Thus, the parental evaluation of their target children's postural and locomotive pattern became higher when their target children were aged between 6 and 23 months.

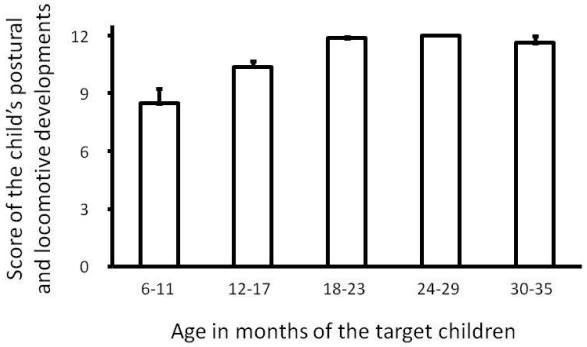

Figure 2: The mean scores of the child's postural and locomotive developments in each group of participants. T-bars represent standard errors.

3.3 Relationship between parental awareness of infant pointing and infants' postural and locomotive developments

There was a common tendency between the results of the comparison of the score of parental awareness of infant pointing and the comparison of the parental evaluations of their target children's postural and locomotive patterns. Hence, both parental evaluations became higher when their target children were aged between 6 and 17 months. The scores of the target children's postural and locomotive developments, which were given by the participants whose target children were aged between 6 and 17 months, ranged from 3 to 12.

To investigate whether these evaluations when their target children were aged between 6 and 17 months had a relationship or not, we conducted Spearman's rank correlation test. The test revealed a significant positive relationship between the parental awareness of the infants' pointing gestures and the children's postural and locomotive developments (Figure 3; $rs = 0.64$, $n = 46$, $p < 0.01$). The positive correlation was still significant after removing the effect of the age (in months) of the target child (partial correlation coefficient, $rp = 0.51$, $t = 3.87$, $df = 43$, $p < 0.01$).

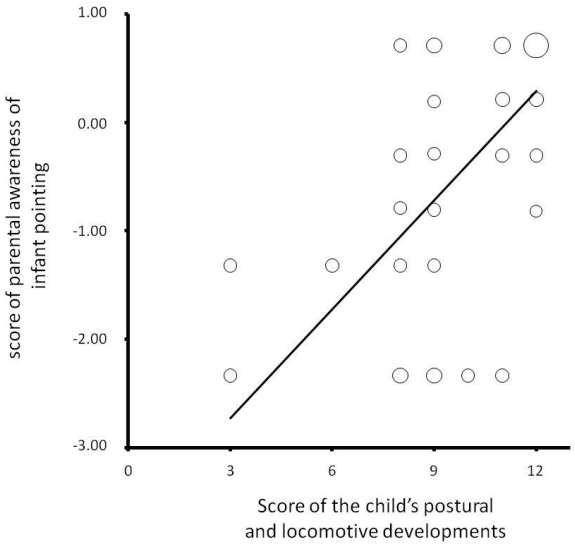

Figure 3: The scores of parental awareness of infant pointing in relation to the scores of the infants' postural and locomotive developments. The size of the circle represents the number of participants whose scores are same; the bigger the size, more participants have the same scores.

We divided the participants whose target children were aged between 6 and 17 months into two groups: (a) the group of participants who scored their target children's postural and locomotive developments more than 9 (the child has been able to stand by himself/herself for a second) ($n = 34$) and (b) the group of participants who scored their target children's postural and locomotive developments less than 8 (the child has been

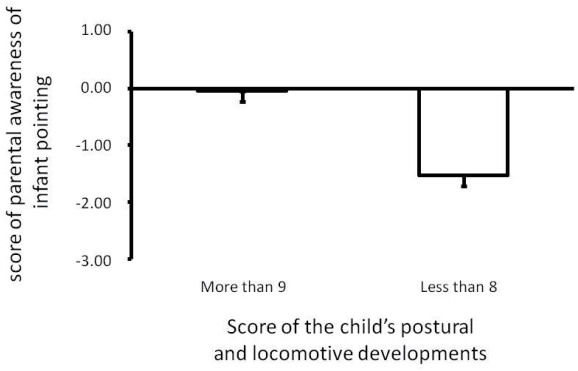

Figure 4: The mean scores of parental awareness of infant pointing in the group of participants who scored their target children's postural and locomotive developments more than 9 and less than 8. T-bars represent standard errors.

able to stand while holding on to something) (n = 12). A t-test on mean score of parental awareness of infant pointing yielded a significant difference between the two groups (Figure 4; -0.05 vs -1.53; t (44) = 4.10, $p < 0.01$). This means that the participants who scored their target children's postural and locomotive developments more than nine evaluated the frequency of pointing gestures by the children higher than those who scored less than 8. This significant difference was not due to the difference in the age of the target children because there was no significant difference in the age of the target children between both groups of participants (11.41 vs 13.68; Welch's t-test: t (14.45) = 1.80; *n.s.*).

4. Discussion

Previous studies have shown that infants make pointing gestures more frequently in their second year of life than when they become 11 months old and have just started making pointing gestures (Blake et al., 2003; Leung & Rheingold, 1981). Perhaps this is because the locomotive development of infant increases the parents' awareness of pointing gestures by infants, and they respond to the gestures apparently. In this study, we revealed that the infants' postural and locomotive developments affects the parents' awareness of pointing gestures by infants for the first time.

We found that the parental awareness of infants' pointing gestures increases when infants are aged between 6 and 17 months. This result supports the previous study conducted by Vallotton (2009). She found that the pointing by infants increasingly affected nursery staff's responsiveness as infants got older. This suggests that infants' pointing gestures have more impact to the nursery staff as the infants get older. Our result is in line with her study; the parents' evaluation of the frequency of pointing gestures by infants become more higher when the infants are in the second year of life, than when they are yet to become one-year-olds with their pointing gestures just having emerged. We also found that the infants' postural and locomotive patterns develop when the infant are aged between 6 and 17 months. From the range of the score, it is suggested that infants of this period develop their postural and locomotive patterns from the stage when they started holding his/her head up to the stage when they can walk adequately. Such postural and locomotive developments occur within the period in which the parents' evaluation of the frequency of pointing gestures by infants become higher, suggesting that the infants' postural and locomotive developments are related to the parents' evaluation of the frequency of pointing gestures by infants.

The correlation analysis between infants' postural and locomotive developments and parents' awareness of pointing gestures by infants supports this idea. We found that infants' postural and locomotive developments and the parental awareness of pointing gestures by infants was correlated, even if we controlled the age of the infants. This suggests that the correlation between parental evaluation of the frequency of pointing gesture by infants and the infants' postural and locomotive developments is not spurious, but actual. That is, if the ages of the infants were uniform, parents make a higher evaluation on the frequency of pointing gestures by infants who develop their postural and locomotive patterns better.

Why do the parents of the infants with a developed postural and locomotive pattern make a higher evaluation on the frequency of pointing gesture by infants? One possibility is that when infants begin to move independently from their parents, the parents would begin to use their infants' pointing gestures as cues to understand their infants' psychological state. If the infants' postural and locomotive patterns are not mature, the parents frequently hold or carry them. In such closely attached situations, parents easily guess infants' psychological state from the infants' facial expression or gaze direction. Contrastingly, when infants acquire a developed postural and locomotive pattern, parents' opportunity to hold their infants decreases and the infants start to move by themselves. In this situation, a physical distance is created between parents and infants, and it becomes difficult for parents to know what their infants think or want only from their facial expressions or gaze direction. Instead, parents would have to guess what infants want, feel, and think from the pointing gestures by the infants. This idea was supported by our result; the parents whose infants could stand or walk by themselves evaluated the frequency of their infants' pointing gestures higher than those whose infants could not stand on their own. This result suggests that the parents whose infants could move independently observed their infants from a distance and thus used pointing gestures by infants as cues to understand the infants' mental state. Contrastingly, the parents of the infants who cannot move independently, would support their infants immediately close to the infants, thus not use pointing gestures of infants but use other behavior such as facial expression or direction of the gaze as a cue to guess the infants' psychological state.

Because this study was conducted using a questionnaire, we could not observe how the parents and infants really interact. To know whether the physical interspace between infants and parents affect the cues that parents use to guess the infants' mental state, future research should examine the interaction between infants and parents and determine how parents communicate with infants who are in various distances.

In sum, it was revealed that parental awareness of infant pointing gestures is related to the development of infants' locomotive patterns, suggesting that parents increase their opportunity to guess their infants' psychological state from the infants' pointing gestures as the infants' postural and locomotive patterns develop. The more infants' locomotive patterns develop, the more parents attend to their infants' pointing gestures, and the more they respond verbally to the infants' pointing gestures. This could motivate infants to make pointing gestures, thereby

leading them to the increase their frequency of pointing gestures in their second year of life.

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Note

(1) Since a few more questionnaires were kindly distributed by the staff of the nursery schools, it is possible that the collection rate was slightly lower than 62.2 %.

(2) We had asked several more extraneous questions that were not used in the analysis of this study, for example, "Do you use a baby chair to sit your infant down at mealtime?"

(3) Spearman's correlation analysis showed a significant correlation between the parental evaluation of the frequency of imperative pointing and declarative pointing of the target children ($rs = 0.78$, $n = 129$, $p < 0.01$). The high correlation was significant even after the effect of the target child's age in months was removed (partial correlation coefficient, $rs = 0.76$, $t = 13.15$, $p < 0.01$). This means that the parental evaluation of the frequency of imperative pointing was highly linked to that of declarative pointing gestures, suggesting that the parental evaluations of the frequency of both type of pointing gestures by their target children was highly interdependent. Therefore, we have combined these evaluations in the index of the parental evaluation of the frequency of pointing gestures of their target children.

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