Master Thesis

The Development of Pointing in Infants from 8 to 12 Months in Relation to Parent's Pointing.

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December 2011

Abstract

When it comes to the origins of index-finger pointing two conflicting approaches exist in literature; individualistic and social-pragmatic approaches. These theories expect different outcomes when it comes to the relationship of parent and infant pointing. Using a longitudinal approach, we investigated the relationships of parent and infant index-finger pointing between 8 and 12 months of age. We found mutual relations between infant and parent pointing, suggesting further support for a social pragmatic approach.

Introduction

Infants start to point with their index-finger between 8 and 15 months (Butterworth and Morissette (1996), Camaioni et al. (2004); Carpenter, Nagell and Tomasello (1998)). Pointing is very likely to be a human universal (Kita, 2003). The term 'pointing' mostly denotes a movement with a more or less extended arm and an extended index-finger. In the development of pointing however one should distinguish two types of pointing; whole-hand pointing and index-finger pointing (Lock et al., 1990; Franco and Butterworth (1996); Liszkowski and Tomassello, 2011).

The use of gestural communication by infants is foundational in the acquisition of language (e.g., Iversonand Goldin-Meadow, 2005) and the index finger pointing gesture has a predictive and facilitative relation with speech (Rowe and Goldin- Meadow, 2009). While the function of the pointing gesture in the acquisition of language is well established, the origins of the pointing

gesture are debated and little is known. The debate is between individualistic and social-pragmatic approaches (Liszkowski and Tomasello, 2007).

In individualistic accounts the pointing behavior stems from other individualistic behaviors such as attempts to reach for an object (Vygotsky,1978) or an extension of close fingertip exploration (Lock et al., 1990; Shinn, 1900/1975). These kinds of behavior becomes social after infants experiences the reactions of the parent on the pointing behavior. The infant learns how the adults respond and infants adjust their actions accordingly (Carpendale and Carpendale 2010). Also according to another individualistic theory non-communicative behavior becomes communicative (Bates et al., 1975) i.e. pointing starts of as a non-communicative behavior and later becomes communicative.

In contrast to individualistic accounts, within a social-pragmatic account pointing is considered to be part of a social activity right from the onset. Pointing emerges for instance from a primal motive to share experiences (Bruner, 1983). Tomasello et al. (2007) consider infant pointing to be based on more social-cognitive skills of shared intentionality, like joint attention and the ability to form joint intentions.

Whereas the parental input in both accounts is important, only in the social-pragmatic account it is paramount from the beginning on. Within a social-pragmatic account one would expect parent behavior to influence the development of pointing heavily from the start. The precise influence of parent behavior on the development of infant pointing is however not yet clear.

A few studies investigated the development of pointing. Carpenter, Nagell and Tomasello (1998) investigated the development of pointing and other social cognitive skills in infants from 9-15 months. They found that the most common order of emergence of the five major social-cognitive skills they investigated was: 1) joint engagement 2) communicative gestures 3) attention following 4) imitative learning 5) referential language. Although Carpenter et al. investigated the development of pointing in the context of social-cognitive skills, they didn't take the parental input of infants into account.

Based on a diary study of mainly one infant, Carpendale and Carpendale (2010) concluded that infants first use their extended index finger as a manifestation of their own attention, stemming from the tactile exploration of close-by objects. When infants become aware of the meaning of their action for action the gesture bit by bit becomes social in its use. The problem with this methodology however is that not every interaction between infant and parent are described, but only those which the parent deemed as significant. This gives a bias in the investigated interactions

and for instance frequency effects can't be reliable investigated.

Lock et al. (1990) studied the emergence of pointing in a social context and studied also the mothers point during free play. They concluded that pointing doesn't have its origins in failed reaching, as some individualistic accounts suggest. Furthermore pointing is not used for demanding objects and finally the action of pointing is not acquired by imitation. “Adults drived models of the frames within which pointing may be used, not models of the action itself.” However, one should be cautious in interpretation the results of this study, since a cross-sectional design has been used. Therefore the developmental patterns found may be different.

Liszkowski and Tomasello (2011) used a new method, the decorated room, to elicit spontaneous pointing of both infants and parents. They studied the differences between infants who pointed (also) with their index-finger and infants who pointed only with the whole-hand. They found that infant's index-finger pointing and whole-hand pointing have completely different profiles. Infants who pointed with their index-finger pointed more than infants who pointed with their whole hand, also were their points accompanied more with vocal sounds. Index-finger pointers also showed a better comprehension of points, because they also understood the referential intention behind a point, where whole-hand pointers did not. Finally, there are different relations between parent's points and infant's points defined by hand shape. Index-finger pointers pointed significantly more than their parents and whole-hand pointers pointed less than their parents. Infants who pointed above the median had parents who pointed above the median. Since Liszkowski and Tomasello (2011) only investigated infants at 12 months who already could point, conclusions about the development of pointing are rather limited. It remains unclear how parents pointing behavior influences the development of pointing. To say more about the development of pointing, one needs a longitudinal approach.

In this paper we take a longitudinal approach to investigate parents influences' on the development of infants' pointing. Infants from 8-12 months together with their parents were tested in a setting, which is known to elicit spontaneous pointing: the decorated room.

In a first set of analyzes the development of the pointing of infants is investigated. How does the pointing of infants change from 8 to 12 months and what changes are there regarding hand-shape? In an individualistic paradigm of the development of pointing, one would expect the developmental patterns of whole-hand pointing and index-finger pointing to be related. In such an account whole-hand pointing can be seen as a stage before index-finger pointing. Whereas completely different trajectories of development of index-finger and whole-hand pointing would

support a social-pragmatic paradigm. In this paper we take a social-pragmatic stance so we expect different trajectories in the development of whole-hand and index-finger pointing.

A second set of analyzes investigates parent's points. Do parents points also show a developmental pattern? And how does this pattern differ from the infant's developmental patterns? When the parents patterns are really different from infant's developmental patterns, one could rule out an imitation account of the development of pointing.

The final set of analyzes concern the relations between the infant and the parents points.

A social-pragmatic account predicts the amount of parent pointing to be related with the frequency of infants' pointing. But also in individualistic approaches one expects this relationship. The difference however is that in an individualistic approach the frequencies of pointing between infant and parent are only related after the infant started with pointing, while the social-pragmatic accounts predict also important influences of parents behavior on the infant before the infant starts with pointing. Following a social-pragmatic account we expect parents behavior on the first two sessions to be predictive for the infants index-finger pointing behavior on later sessions i.e. the age of emergence.

Methods

Participants

Nineteen parent-infant dyads participated in the study from infant age 8 through 12 months (10 girls, 9 boys) last visit mean age 366 days, range= 349-398 days, The infants were recruited from a database of parents who had agreed to participate in infant studies. Parents were told in advance that we studied how infant's general cognitive skills developed during months of the study. Afterwards the parents were debriefed and informed about our focus on the development of communicative skills and pointing in particular.

Setup

Figure 1 shows a photo of the 'decorated room' in which twenty interesting objects are displayed. This included for example pictures, a paper lantern, a light, feather boa and a wind mill. These materials can be used in cross-cultural investigations (Liszkowski and Brown, 2007). The setting was broadly analogous to an exhibit or museum. The scene was recorded by four DV cameras, each in one corner.

Fig. 1 photo of the 'decorated room'.

Procedure

The dyads came for monthly visits, during a period of 6 months. Each time, the same procedure with the same objects was run. During a visit parents were asked to hold their infant on their hip during the decorated room assessment and together with their infant take a look at all the things exhibited. Pointing was never mentioned during the instructions. A request was made not to play with the things exhibited. After the instruction, the experimenter left the room and recorded the parent and the infant for five minutes.

Coding

In both real-time and frame-by-frame videotapes were coded for the occurrence of pointing. The same coding scheme was used as in Liszkowski and Tomasello (2011). In order for a behavior to be coded as pointing the following conditions had to be met: 1) The arm had to be either fully or half extended toward a perceptible object or locations, which had to be accompanied by looks in that direction. 2) the behavior was no clear attempt to grab or touch. Furthermore hand shape of the pointing was distinguished into index-finger pointing and whole-hand pointing. A point was considered to be an index-finger point when the index-finger was distinctly extended relative to all other fingers, when this wasn't the case the point was coded as whole-hand point.

Also the age of emergence was code. This was defined as the first month in which an infant pointed at least twice with their index-finger during the session. This behavior had to be shown at least two sessions in a row. If an infant pointed at least twice for the first time during the last session, this was also counted as the month of emergence.

Results

Infant behaviour

The distribution of the total amount of infant points is non-normal at 9, 11 and 12 months (Kolmogorov-Smimov, p = 0,046 (9 months), p = 0,001 (11 months), p = 0,017 (12 months). Therefore non parametric statistics are used for the analyzes. The total amount points of infants changed significantly from 8 months (mean 0.351 , range 0 – 1,248) to 12 months (mean 3.203, range 0 – 11.016), Friedman $X^2(4) = 20,287$, $p < 0,001$. Regarding the pointing behavior of infants one should be careful to make a distinction between pointing with the index finger and hand pointing, see Figure 2.

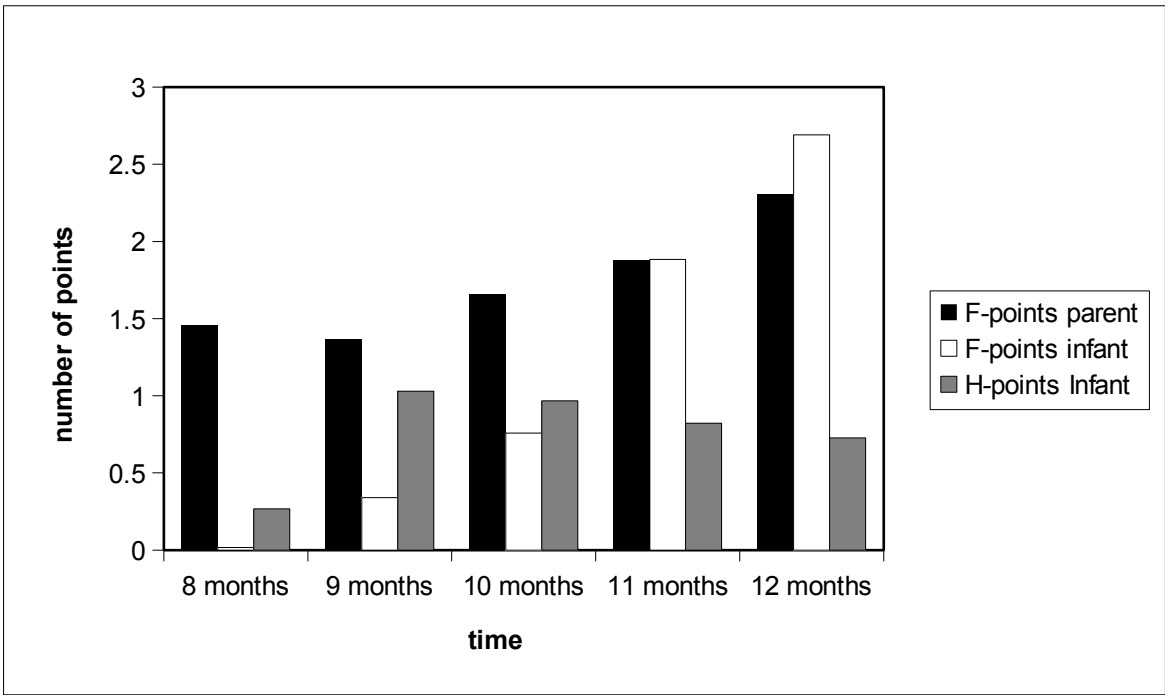

Figure 2: Number of points per minute for infants and parents.

Index-finger pointing

A significant change in the frequency of the index-finger points was found, Friedman $X^2(4) = 10,3570$, $p < 0,001$. The distribution of points ranged from 0 to 9,8 points per minute with a median 1.62 at twelve months. Post-hoc analysis with Wilcoxon Signed Tests were conducted and revealed

that the amount of index-finger pointing at age 8 differed significantly with the amount of index-finger pointing at the other ages: 8 and 9 months (Z = -2.100, p = 0.036), 8 and 10 months (Z = - 2. 192, p = 0.028), 8 and 11 months (Z=-2.803, P=0.005), 8 and 12 months (Z = -3.181, p = 0.001). Also at 12 months the frequency of infant's index-finger pointing differed significantly from all other ages: 9 and 12 months (Z = - 3.180, p = 0.001), 10 and 12 months (Z = -2.132, p = 0.033), 11 and 12 months (Z = -2.417, p = 0.016). Furthermore a significant difference in the frequency of index-finger pointing was found between 9 and 11 months (Z = -2.090, p = 0.037).

Not only the change of frequency of index-finger points was significant, also the number of infants who pointed with their index-finger changed drastically, see Figure 2. None of the infants pointed with their index finger at the age of 8 months. The median age of emergence of index pointing is 11 months. At the age of 12 months 15 out of 19 infants pointed with their index finger in the decorated room, see Figure 2. The increase of the number of infants who pointed was significant. (Cochran Q (4) = 28,55 , p < 0.001). To find out where the increases across time-points are in number of index-finger pointers multiple comparisons using the McNemar Test were run. Significant changes in number were found between the ages 8 and 10 (p = 0, 016), 8 and 11 (p = 0,002), 8 and 12 (p = 0,000), 9 and 12 (p = 0, 016).

Whole-hand pointing

Compared to index-finger pointing different developmental patterns were found for whole-hand pointing. First, there is no difference in the frequency of hand pointing across the months (Friedman $X^2(4) = 5.558$ p = 0.235). See Figure 2. Visual inspection of the graph suggests a possible significant difference in the frequency of hand points between 8 and 9 months of age. This difference however is a trend (Z = - 1.938, p = 0.053). Second, no significant changes in the number of infants who showed whole-hand pointing were found (Cochran Q (4) = 2.706, p = 0.608).

Third, the differences in the frequencies of infant's index-finger and whole-hand pointing within a session were tested with Wilcoxon Signed-Rank Tests. Significant differences were found between the frequency of index-finger and whole-hand pointing at the ages 8 months (Z = -2.760, p = 0.006), 9 months (Z = -2.062, p = 0.039) and 12 months (Z = - 1.965, p = 0.049).

To test the relationship between the age of emergence of index-finger pointing and hand pointing correlation analyzes were run. There was a significant negative relation between the amount of hand pointing at age 9 months and the age of emergence: Spearman's rho(18) = - 0.699, p = 0.001. The more hand pointing an infant shows at 9 months, the earlier the infant starts with index-finger pointing.

Parent behavior

The distribution of the total amount of parent points is non-normal at 10 months (Kolmogorov-Smimov, p = 0,041). At 9 months there's a tendency to non-normality (Kolmogorov-Smimov, p = 0,052). Therefore non parametric statistics are used for the analyzes.

The frequency of parents' index-finger points showed a significant increase (Friedman $X^2(4) = 10.939$, p = 0.027), see Figure 2. Post-hoc analysis with Wilcoxon Signed-Rank Tests were conducted. This revealed significant differences in the amount of parent index pointing between age 8 and 12 months (Z = -2.580, p = 0.010), 9 and 12 months (Z = - 2.585, p = -0.010), 10 and 12 (Z = -2.896, p = 0.004). No other significant differences were found. Regarding the number of parents who pointed with their index-finger on a session no such increase was found. 74 % of all parents pointed with their index-finger on all sessions. 16 % pointed on four sessions. 5 % didn't point with the index-finger on 2 sessions and 5 % didn't point at all during all the sessions. On the first session 2 parents didn't point, on the second session 4, on the third session 1, on the fourth 2 and on the fifth session 1 parent didn't point with the index-finger. Index-finger pointing constitutes the vast majority of parents points (90.8%), the rest of the pointing consists of whole-hand points (1.2 %), upwards index-finger points (1.0) and points from which the shape couldn't be determined (7.0 %). Because the vast majority of parent's points were index -finger points and there were little whole hand points, no analyses were conducted on the relation between whole-hand points and index-finger points.

Infant and Parent behavior

To test the differences in the frequency of index pointing between parents and infants paired Wilcoxon Signed Ranks Test were conducted, they revealed a significant difference at 8 months (Z = -3.201, p = 0.001), 9 months (Z = -2.982, p = 0.003) and 10 months (Z = -2,201, p = 0.028). To further examine the relation between parent and infant index points a linear mixed model was conducted. Because we only considered fixed effects, violating the normality assumption doesn't influence the results (Verbeke and Molenberghs, 2009). The age in months and the amount of parent index-finger pointing were taken as factors. The age in months of the infant significantly predicted the frequency of index points, F(4, 65.025) = 4.567, p = 0.003. Parent index pointing didn't show a main effect F(1, 90.997) = 0.850, p = 0.359, but parent index-finger pointing and the age of the infant showed a significant interaction F (4, 64.443) = 3.473, p = 0.012 . The more a parent points at age 10 the less is the difference in infants index-finger pointing between 10 and 12 months of age.

Also direct correlations between parents points and infant's index-finger points were run. Parent-

pointing at 8 months correlated with infant pointing at 9 months, r = 0.77, p = 0.000. Infants index-finger pointing at 9 months also correlated with parents pointing at 10 months, r = 0.58, p = 0.15. A trend was found between parent pointing at 10 months and infant pointing at 11 months. One should treat these correlations with care, since theye are not corrected for the amount of correlations done.

In order to test the possible connection between the amount of parent's index-finger pointing and the age of emergence correlations were run. Parent's pointing at given point in time didn't correlate with the age of emergence, for example the frequency of parent pointing at 8 months did not correlated with the age of emergence.

Discussion

The current study investigated the development of pointing in infants from 8 till 12 months of age. The majority of the tested infants start to point with their index-finger during 9 and 12 months of age. This is a similar pattern as already found in the literature, where the emergence of index-finger pointing is reported between 8 and 15 months of age (Butterworth and Morissette (1996), Camaioni et al. (2004); Carpenter, Nagell and Tomasello (1998)).

The development of index-finger pointing and whole-hand pointing show different patterns. First, while there's no significant difference in the frequency of infant's whole-hand points during the period of testing, the amount of index-finger pointing increases drastically. Thus the frequency of whole-hand pointing remains the same, even after the infant has started to point with the index-finger. Index-finger pointing does not replace whole-hand pointing. Second, also in the number of infants who show whole-hand pointing and index-finger pointing different patterns are found. The number of infants who point with their whole-hand doesn't show any significant differences, there's however a significant increase in the number of infants who start to point during 8-12 months. Where no infant points at 8 months, at 12 months 15 out of 19 infants point with their index-finger.

At 9 months there's a correlation between the amount of hand pointing and the age of emergence. The more hand pointing an infant shows at 9 months, the earlier the infant starts with index-finger pointing. Whole-hand pointing could act as a precursor for index-finger pointing (Liszkowski and Tomasello (2011)), since infants point first with their whole-hand and then with the index-finger and not vice versa.

In this study, the found differences in the development of pointing are morphological of nature. However, there are good indications that these differences also have a qualitative nature. Whole-

hand pointing and index-finger pointing have a different profile in terms of use. In infants imperative pointing is more associated with whole-hand pointing than with index-finger pointing. Index-finger pointing is more used in a declarative situation (Franco and Butterworth (1996) and Cochet and Vauclair (2010)). Furthermore, in a comparison between infants who pointed solely with the whole-hand and infants who pointed also with their index- finger, Liszkowski and Tomasello (2011) found better comprehension of pointing for the index-finger pointers. In contrast to whole-hand pointers, index-finger pointers understand the referential intention behind a point. Also Masataka (2003) argues that whole-hand pointing and index-finger pointing are qualitatively different and two distinct developmental processes. He found index-finger pointing to have communicative precursors while whole-hand pointing has not. Thus, index-finger pointing and whole-hand pointing can be understood as two distinct developmental processes.

Does the view that index-finger pointing and whole-hand pointing are distinct developmental processes also entail that the development of index-finger pointing is a social-pragmatic process? Not necessarily. It depends on the type of individualistic approach one considers. Vygotsky's (1978) view that from the individual attempts of reaching for an object the infant develops pointing, predicts that index-finger pointing develops out of hand-pointing. Because whole-hand pointing and index-finger pointing show different cognitive profiles and whole-hand pointing stays in the repertoire after index-finger pointing emerges, Vygotsky's view seems unlikely.
One individualistic approach which can hold that index-finger pointing and whole-hand pointing are two separate developmental processes is if one takes index-finger pointing to be an extension of close fingertip exploration. Index-finger pointing starts of as directing the infants own attention and becomes social after the infant experiences the reaction of the parent on this pointing behavior. From this reaction the infant learns how adults respond on points and infants adjust their actions accordingly (Carpendale and Carpendale 2010). This view can allow that whole-hand pointing stems from reaching actions and index-finger pointing has its basis in directing the infant's own attention. Regarding the amount of parent-pointing this account would suggest that parent-pointing goes up at the moment an infant starts to point, it's a reaction to the infants pointing behavior.

In the current study the central research question was the relationship between the parents pointing behavior and the infant's development of index-finger pointing. Different relations between parent pointing and infant index-finger pointing has been found. Parent pointing at 8

months is correlated with infant index-finger pointing at 9 months. Infant index-finger pointing is correlated with parent pointing at 10 months. The more a parent points at age 10 the less is the difference in infants index-finger pointing between 10 and 12 months of age. Parent pointing at 10 months is marginally correlated with infant pointing at 11 months.

These data favor a social-pragmatic account of the development of pointing. First, contradicting the individualistic own attention directing account of infant pointing parents points are expected to increase in the month of emergence, but parent pointing behavior influences infant behavior before the infant starts to point. The frequency of parent pointing at 8 months is correlated with infant pointing at 9 months. This suggest parent's pointing to be important in infant's development of index-finger pointing. That no main effects of parent pointing of the frequency of infant pointing was found suggest that parents don't always have the lead in the development of index-finger pointing. Infant and parent mutually influence the behavior of the infant. When an infant starts to point, parents react on that with more pointing. Parents adapt to their infants behavior. This explains the found result that infant index-finger pointing at 9 months is correlated with parent pointing at 10 months. A social-pragmatic account of infant pointing is very accommodating for such mutual influence paradigm, because it emphases the social context in which pointing can take place.

For future research it's a good idea to also consider data relative to the point of emergence, instead of looking at the data bound to the months. For instance to look at parent behavior a month before infant's index-finger pointing behavior emerges. With these data more insight into the specific patterns between parent behavior and the emergence of pointing can be gained, because the big variance in the age of emergence limits strong conclusions about the relationship between parent pointing and the developmental trajectory of infant index-finger pointing. The current sample however was to small for such elaborate analyzes. This study was an exploratory study on the influences of parent pointing on the development of infant pointing and vice versa. It gives good directions, but testing with a bigger sample and more age groups can give more solid data. Age groups above 12 months can make the picture more clear, because then all infants show index-finger pointing and relative data to the point of emergence can be done. With age groups below 8 months the influence of parent behavior on infants whole-hand pointing can be studied. This is unknown territory and might also shed a clearer light on the relation of whole-hand pointing and index-finger pointing.

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