

A LONGITUDINAL CASE STUDY ON THE RELATIONSHIP BETWEEN EARLY GESTURES AND LEXICAL DEVELOPMENT

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ABSTRACT

It has been suggested that children who are early or frequent users of gestures also develop expressive language at an early age. This assumption has been questioned on the grounds that studies performed under controlled laboratory conditions in which gestures are elicited in the absence of contextual support (*e.g.* in relation to a new object) have shown to correlate positively to vocabulary size, while parent observations of gestural behavior performed with associated objects in naturalistic settings have not. The current longitudinal case study of infants' early gestural and linguistic development is based on parent reports collected by the standardized Swedish analog of MacArthur Communicative Development Inventory (CDI). Results showed that a positive correlation between frequency of use of early gestures and vocabulary size could be found for a subset of subjects.

Keywords: lexical development, gesture

1. INTRODUCTION

This paper describes a pre-experiment for the assessment of cortical activation with EEG (electroencephalography) in response to perception and production of new *vs.* familiar gestures in infants. Thus, analysis of earlier collected longitudinal data on gesture/vocabulary was here performed as a first step towards reaching the goals of the "Early Development of Hemispheric Specialization for Speech Processing" project. The general aim of the project is to study establishment of language-related specialization in the brain and its specific links to different phases of language development early in life. Use of gestures and imitational learning are in this project seen as entwined parts of language development. In other words, infants' communication is likely not exclusively vocal in nature, but includes non-verbal behaviors such as facial expressions, eye contact, body movements and hand gestures [11]. In addition, imaging data within the current project will be collected to assess different linguistics

tasks across typical and atypical populations. Results from these studies may have a value in diagnosis of early signs of atypical language development and for development of linguistic strategies that promote growth of functional language skills in children with *e.g.* autism spectrum disorders (ASD).

Research questions on development and frequency of use of gestures correlated to progress in lexical development have traditionally assessed gestural correlates of babbling, comprehension and production of words and first word combinations, as well as vocabulary size at school entry (*e.g.* [21]). Naturally, answers to these questions depend on how gestures are assessed. Gestures can be analyzed as deictic acts, such as giving, showing or pointing to initiate common focus, or as representational gestures that have a meaning independent of the object around the child. Further, gestures may be elicited (typically the child is asked to do what the adult is doing) or performed spontaneously. Also, imaging studies suggest that differences in neural activity do not correspond to a split between use of language *vs.* gestures, or to perception *vs.* production of words or gestures in a clear cut way. Instead, the amount of *contextual support* that is needed for successful performance at different stages of development seems to be one of the relevant dimensions [1].

2. BACKGROUND

Although it is still controversial whether language develops in isolation or is built upon more general cognitive abilities, investigators today following either the Vygotskian or Piagetian tradition agree on that language skills are associated with development of gestural skills and observational learning.

In specific, a link between development of joint attention, *i.e.* when a child attends to an object or action that an adult is looking or pointing at, and following abilities in both gesture and language has been found [6]. Joint attention and symbolic play are seen as part of the child's subsequent

progress in imitation of novel sounds and actions [13, 18, 20]. That is, an adult's attention towards an object seem to attract more looking in children already in infancy [19] and opens up for a possibility for the adult to give a verbal etiquette on the object in focus [22]. Against the background of delayed (or non-reached) milestones for joint attention, symbolic play and imitation in children with ASD, it has been suggested that deviant language in these children might indeed be *secondary* to a primary deficit in gestural and imitational learning [7].

Other suggested language milestones correlated to gestural learning among typical populations are:

- Canonical babbling, *i.e.* production of repeated consonant-vowel segments (*e.g.* ba), achieved between 6 to 8 months, appears to be linked to onset of rhythmic hand banging [16, 17].
- Word comprehension emerging between 8 to 10 months, seems to be correlated with deictic gestures and culturally derived gestural routines (*e.g.* waving good bye) [2, 3].
- Naming things, at 11-13 months, starts often along with production of recognitory gestures, *i.e.* actions associated to specific objects (*e.g.* putting a phone to the ear) [2, 3].
- Appearance of first word combinations, at 18 to 20 months, is accompanied by gesture-word combinations (pointing while naming) [4, 14].
- Ability to remember and imitate sequence of 3-5 arbitrary ordered manual actions is correlated with the onset and growth of grammatical production from 34 to 30 months [4].

2.1 The role of contextual support

In laboratory settings children are typically asked to imitate a gesture that they have never seen before and/or produce a familiar gesture without associated object (*e.g.* drinking gesture modeled empty-handed or with wrong object). The number of correctly performed gestures in these settings without contextual support has shown to correlate with progress in language production. However, this relationship is not present when gestures are performed with associated objects, typically observed in naturalistic settings or through parent report [1].

Efforts to explain this dissociation with help of neural imaging data in adults have found that when hand gestures or mouth movements were performed with the object present (*e.g.* picking up

a ball, or eating an apple) bilateral frontal and parietal networks were activated, but when the actions were performed without the object (*e.g.* reaching towards nonexistent object, or mouth chewing) only frontal activity was found [5].

Also, right-hemisphere bias during reproduction of something new relied on extrinsic contextual cues, as opposed to perception of meaningful well known gestures, has been observed in adults [8, 12]. For example, activity in several right parietal regions was shown in hearing non-signers compared with experienced signers of a sign language [15]. The finding that infants with lesions in right parietal regions are delayed in development of early communicative and symbolic gestures suggest that also infants typically acquiring new gestures, rely to a great extent on the right parietal system [1].

3. METHOD

The Swedish Early Communicative Development Inventory (SECDI) [9], which is a standardized analog of the MacArthur Communicative Development Inventory (CDI) [10] was used approximately once/month to collect data. The inventory is composed of two versions. The first version, SECDI: Words & Gestures is a checklist for 8-16 month old infants and the second, SECDI: Words & Sentences is a checklist for 16-28 month old toddlers. In this study, both versions were used. The first version was used to estimate frequency of use of gestures from approximately 6 months and onward, and the second to estimate size of productive vocabulary from 14 months and onward.

3.1. Subjects

The subjects attending the longitudinal study were 25 children (13 girls, and 12 boys, age range 6.1- to 20.6-months by the start point of the project) randomly selected from the National Swedish address register (SPAR) on the basis of age and geographical criteria. All subjects were primarily exposed to Swedish. The parents of subjects were not paid for their participation. Children with missing data on either gestures or vocabulary were excluded from the study resulting in 16 children (10 girls, 6 boys). Number of total gesture and vocabulary data per subject are shown in Table 1.

3.2. Materials and procedure

Frequency of use of 12 deictic and conventional gestures was assessed based on parent reports in response to a checklist called "IIA-Early gestures" in SECDI: Words & Gestures (Table 2).

Table 1: No. of data collection occasions per subject.

Subject	No. data	Subject	No. data
1	2	9	5
2	6	10	5
3	12	11	10
4	10	12	9
5	5	13	9
6	6	14	8
7	3	15	8
8	9	16	10

Table 2: The 12 gestures in "IIA-Early gestures".

Gesture
1. Extends arm to show you something he/she is holding.
2. Reaches out and gives you a toy or an object that he/she is holding.
3. Points (with the arm and index finger extended) at interesting objects or actions.
4. Waves bye-bye on his/her own when someone leaves.
5. Extends hands upward to signal a wish to be picked up.
6. Shakes head for "no".
7. Nods with the head for "yes".
8. Gestures "hush" by placing finger to lips.
9. Requests something by opening and closing the hand.
10. Blows kisses from a distance.
11. Smacks with the lips in a "yam-yam" gesture to show that something tastes good.
12. Shrugs shoulders and shows the palm in an "all-gone" or "don't know" gesture.

Vocabulary size was estimated on parent reports in response to a checklist of 710 words in SECDI: Words & Sentences, divided into 22 (broadly) semantic categories such as animals, vehicles, toys, food items, body parts, articles of clothing etc. The materials were collected 2004-2007 at the Phonetic laboratory, Stockholm University. The subjects visited the lab approximately once per month.

4. RESULTS

The age of subjects (N=16) by the time point of gesture data collection was 6.3 to 26 months, and 14.2 to 44.6 months for vocabulary data collection. A relative (%) frequency of use of gestures (sum of scores/12) and a relative (%) vocabulary size (sum of scores/710) were estimated for each subject per data collection date (Figure 1). One vocabulary data point (the first) was included per subject.

Relative gesture and vocabulary scores for subjects (N=4) with 10 or more data points are

plotted in Figure 2 (this time only gestures that received score 3= "often"). Linear regression revealed a positive significant relationship between relative gesture/vocabulary score and age $r=0.690$; $P < .001$.

Figure 1: Relative frequency of use of gestures and relative vocabulary size are both shown on the y-axis (%) for each subject (N=16) per data collection date. Gestures reported by parents as used "sometimes" are shown in circles, and gestures used "often" are shown in triangles. Age (in months) is shown on the x-axis.

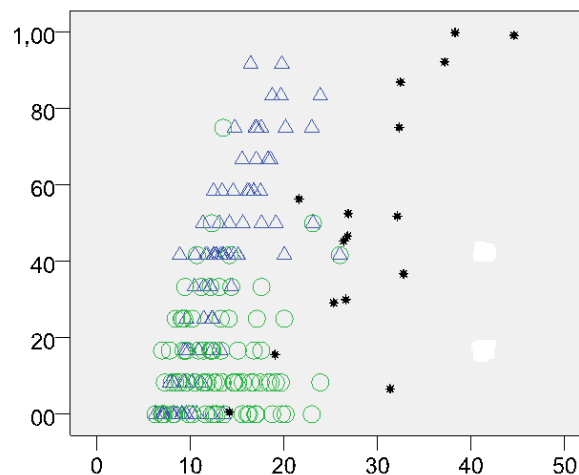
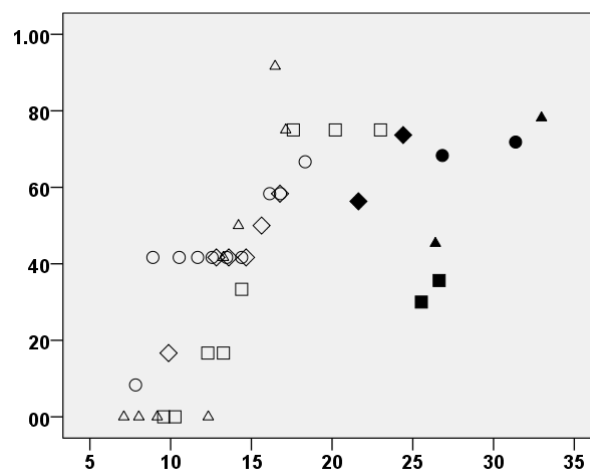


Figure 2: Relative gesture and vocabulary scores for subjects (N=4) with 10 or more data collection points are shown on the y-axis. Subject 3: gestures (unfilled circles) and vocabulary (filled circles), Subject 4: gestures (unfilled triangles) and vocabulary (filled triangles), Subject 11: gestures (unfilled squares) and vocabulary (filled squares), Subject 16: gestures (unfilled diamonds) and vocabulary (filled diamonds). Age (in months) is shown on the x-axis.



5. DISCUSSION

Results showed a positive relationship between relative gesture/vocabulary score and age for a subset of subjects with 10 or more data points.

These results indicate that use of gestures based on parent observations, performed presumably with ample contextual support, might to some extent be correlated to vocabulary size. The early gestures in this study may be defined as deictic (gesture 1-3) and as conventional gestures; culturally derived gestural routines or gestures that may have meaning more or less independent of objects around the child (gesture 4-12). Naturally, the precise nature and degree of contextual support present in naturalistic settings are difficult to determine. Also, different inclusion criteria (e.g. no. of data points) for subjects are applicable.

Just like language comprehension is guided by top-down processes on the ongoing context, gestures are supported by proprioceptive feedback from relatively large movements in space. In contrast, less context and proprioceptive support is available for fine-grained articulatory movements. This may explain why context is important for young children - who with little experience of the world - try to reproduce their auditory input [1]. Also, if deviant language in children with ASD is indeed secondary to a primary deficit in gestural learning, then contextual support may be of great significance especially for them.

To conclude, gestural skills are evidently connected to development of language skills both in typically and atypically developing children. However, to give a balanced picture of the association between these skills, contextual support needed for performance of gestures must be taken into account.

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