

Which Semantic Synchrony?

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Abstract

Commonly, the relation between gesture and speech is analyzed in terms of semantic synchrony (i.e. whether it is complementing or reinforcing the verbal message). However, these categories reflect a mature semantic system that bears limitation when applied to child language studies. In this paper, thus, we present data from mother-child conversations during joint picture book reading. We present analyses of different forms of speech-gesture-synchrony and show how their results are related to the vocabulary development of the children. We critically discuss the different forms of semantic synchrony and their appropriateness for child language studies.

Keywords: speech-gesture-synchrony, joint attention, language development.

Introduction

It is widely accepted that the ability to make social-pragmatic inferences regarding a speaker's focus of attention and communicative goals is crucial to children's ability to learn language (Ambridge & Lieven, 2011). Children acquire this ability during the first two years of life (Bakeman & Adamson, 1984). On the way to their joint attentional proficiency, children are accompanied and supported by adults and competent interaction partners (Bakeman & Adamson, 1984). Gestures are an important scaffold. Iverson and colleagues (1994) have shown that maternal gestures help to establish periods of joint attention. Murphy (1978) has shown that while reading a book with their children mothers use pointing gestures when they label objects. Such routines like pointing while labeling an object seem to play an important role in educating children to regard a speaker's focus of attention and her or his communicative goals (Marcos, 1991).

Joint picture book reading in infancy has been recognized as providing a pragmatically stable environment in which such routines reliably take place (Kümmerling-Meibauer & Meibauer, 2005; 2011). A pilot study by Rowe and Pan (2004) investigated to what extent maternal pointing during such routines as in joint picture book reading are related to children's vocabulary development. 68 low-income mothers and their 2-year-old children participated in this study. The dyads were videotaped interacting at home. Each

interaction begun with a book, then, the interaction moved on to toys for a total of 10 minutes. In addition to verbal behavior, the mothers' nonverbal behavior was assessed by coding the (a) type of gestures that the mothers performed and (b) the synchrony of their verbal and nonverbal behavior. For the "synchrony", the authors coded the contribution of gesture to speech, i.e. they analyzed whether the gesture reinforced or disambiguated the spoken message or added information to it (see also Iverson & Goldin-Meadow, 2005). The results revealed that mothers spent only 18 % of the whole interaction time 'reading' the book to the child. But the majority of maternal pointing (54 %) occurred just during this time. Mothers produced on average 4.6 points per minute during bookreading while only 0.7 points per minute were produced during a toy play. In terms of scaffolding children's joint attention abilities, Rowe and Pan (2004) found that mothers discussed the joint focus significantly more in book reading, and children were more likely to respond with a label to mother's point in this particular situation rather than in the free play. The structure of this environment might have led to the finding that maternal points-per-minute during book reading (but not during free play) were positively correlated with children's receptive vocabulary a year later.

In sum, although dyads may spend a relatively brief period of time interacting around a book, this form of interaction appears to be one that is particularly facilitative of child vocabulary development. In this situation, maternal pointing reinforces the verbal message (i.e. is redundant with the verbal content) and is often used to discuss a joint focus of attention.

We should highlight the fact that in most of the studies in child language development focusing on gestures, the relation between gesture and speech is usually viewed in terms of semantic synchrony (Iverson & Goldin-Meadow, 2005). This is an 'adult-perspective' coding; it takes the language semantics into consideration, i.e. the way the relation between gesture and speech is accessible to an adult. It is thus reasonable to argue that only a competent speaker can perceive a complementing gesture as such.

In our study, we pursued the goal of replicating the findings reported in Rowe and Pan (2004) with a closer look at the co-occurrence of speech and gestures. We extended the findings provided by Rowe and Pan (2004) in two ways: Firstly, we focused on an earlier

age than Rowe & Pan (2004), since Rowe & Goldin-Meadow (2009a) found the gestural behavior in children of 14 months of age to be particularly predictive of their later language development. Thus, our investigation focused on the children's age of 14 months. Secondly, we developed a coding scheme that provided a child-perspective without actually putting too much language semantics into the coding decisions.

Method

Our data stems from a longitudinal study, where we visited the families at their homes every six weeks starting when the child was 10 months of age until he/she was 27 months old.

Subjects

Here, we report the data from 11 mother-child dyads (6 females and 5 males) that were recruited in Bielefeld (Germany) and its surroundings. Children were 14;17 months old ($SD = 0;12$) on average during the observed interaction. They were 18 and 24 months old during further assessment of their language development. Maternal education level ranged from nine years of education (corresponding to less than a high school degree) to 21 years (corresponding to a Ph.D. degree) ($M = 15.9$, $SD = 4.1$).

Procedure

Here, we present the data from the visit at which children were 14 months old. Firstly, the mother and her child were asked to play freely for 25 minutes with toys that were brought to them. Then, they read a book for about 5 to 10 minutes. The book contained photographs of single objects (e.g. a cup) or two objects in relation to each other (e.g. a cup on a table).

Dependent Measures

For the mothers, we coded their verbal and nonverbal behavior. For the children, we asked the mothers to fill out a language survey (Grimm & Doil, 2000) that is equivalent to the short form vocabulary checklist of the MacArthur & Bates Communicative Development Inventories (MBCDI): ELFRA 1 (level 1, containing information about receptive and productive vocabulary) after each visit and ELFRA 2 (level 2, containing information about productive vocabulary) when the children were 24 months old.

Coding

We coded the mothers' deictic, iconic and manipulative gestures (Rohlfing, 2011), but – as in Rowe & Pan (2004) – we focused on pointing gestures. We used a XML-coding system (MARTHA) for our annotations. It allows us to code in a conventionalized, category-oriented way (Iverson & Goldin-Meadow, 2005). For example, a gesture would be coded for its type (whether it is deictic, iconic or manipulative), then – in the case of a deictic gesture – for its specification (whether it is pointing, giving, showing, etc); finally, the semantics can be captured (whether this gesture is reinforcing or supplementing the verbal utterance). In addition to the pre-defined categories, MARTHA allows us to

calculate the temporal relation between speech and gesture without the pre-defined semantics categories (see 'child-perspective' for details). This way of coding is motivated by the Intersensory Redundancy Hypothesis (Bahrick) suggesting that multimodality (here verbal speech and gesture) selectively attracts infants' attention and gives the highlighted aspects of the world processing priority (Bahrick, Lickliter, & Flom, 2004).

In sum, the relation between verbal speech and gesture could be assessed in two different ways:

- *Adult-perspective*: this coding accesses the relations of gesture and speech by focusing on the semantics of verbal utterances (Iverson & Goldin-Meadow, 2005): The gesture was coded as **reinforcing** if its content was redundant to the content provided within speech; it was coded as **supplementing** when the gestural content complemented or added to the verbal message, e.g. the mother said "look, this is red!" and pointed to a picture with a sock;
- *Child-perspective*: this coding calculated the numeric relation of words to gestures; this way, we obtained the number of maternal words within deictic gestures. Here, the idea is that gestures highlight the verbal message (Booth, McGregor & Rohlfing, 2008) that might then be better perceived as a learning content (Csibra, 2010). In Figure 1, the mother first says "look!", then she performs a pointing gesture, within which she labels the object on the picture and says "A red cup!" From the XML coding, we can calculate how many words were produced within a gesture.

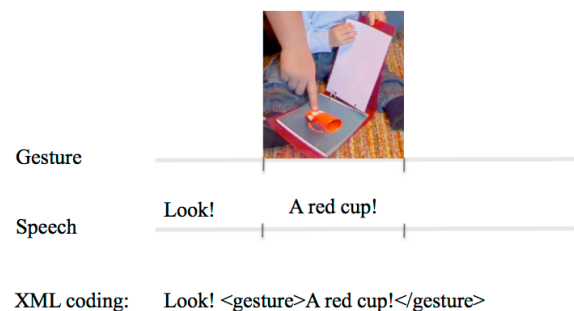


Figure 1: XML coding system.

Results

In the following, we first present the results from the interaction of the dyad and then the relation between the gestural interaction and the child's vocabulary data as reported in the parental surveys.

Concerning the overall gestural interaction, we found only a weak relationship between maternal overall gestural behavior with children's gestural and verbal behavior. However, when we focused on maternal pointing, we obtained significant correlational results: Especially maternal reinforcing pointing gestures at the age of 14 months were marginally positively correlated with the child's overall gestural behavior $r_s(11) = 0.54$, $p < 0.09$. This supports the findings reported in Rowe &

Goldin-Meadow (2009a) suggesting that the child's gestural behavior can be explained by maternal gestural behavior. However, our results confirm this trend only for pointing behavior.

With respect to the child's vocabulary development, we found that overall maternal pointing behavior at the child's age of 14 months was marginally positively correlated with receptive vocabulary $r_s(6) = 0.79, p < 0.06$ and positively correlated with productive vocabulary $r_s(8) = 0.74, p < 0.05$, as assessed by the ELFRA 1 at that age.

When analyzing the relationship between verbal speech and gesture, we firstly analyzed the adult-perspective coding. The analysis revealed that only the reinforcing pointing of the mother was positively correlated with the productive vocabulary $r_s(8) = 0.69, p < 0.05$.

Secondly, we analyzed the child-perspective coding. We found that only the child-perspective coding revealed a relationship to the child's reported vocabulary development at 18 months: The number of maternal words within deictic gestures when the children were 14 months of age correlated positively with the productive ELFRA scores at 18 months: $r_s(9) = 0.75, p < 0.05$. In addition, only the child-perspective coding revealed a relationship to the child's reported vocabulary development at 24 months: Here again, the number of maternal words within deictic gestures at children's 14 months of age correlated positively with the productive ELFRA scores at 24 months: $r_s(9) = 0.75, p < 0.05$. In order to assess the predictive value of this dependent measure, we conducted a regression analysis and found that among all dependent measures (such as maternal overall gestural behavior, maternal deictic gestures, maternal pointing, maternal reinforcing pointing, pointing with speech and words within pointing), only the amount of maternal words within pointing gestures was predictive of ELFRA values at the child's age of 24 months ($\beta = 0.62, p < 0.05$) and explained 39 % of the variance between children in ELFRA at 24 months.

Interestingly, at 18 months of age and in accordance to the adult-perspective coding, the supplementing pointing gesture was correlated with receptive ($r_s(9) = 0.97, p < 0.001$) and productive ($r_s(9) = 0.76, p < 0.05$) ELFRA scores at 18 months. This suggests that at the age of 18 months, at which children are reported to use gesture-speech-combinations by themselves (Iverson & Goldin-Meadow, 2005; Rowe & Goldin-Meadow, 2009b), they also seem to benefit from the semantics in gestural input.

In our last analysis, we asked the question whether the predictive value of this dependent variable can be generalized over different situations. For this, we compared maternal behavior from the free play to the book reading situation. As a result, we obtained no statistically significant result for the free play with respect to maternal gestural behavior predicting the child's reported vocabulary development. Thus, we can conclude that in our data, the predictive value of this dependent variable (number of words within pointing gestures) is limited to the book reading situation.

Discussion

At the age of 14 months, children seem to be sensitive to the mothers' verbal and nonverbal behavior as the nonverbal behavior of the children can be explained by the maternal pointing. Thus, our data from the joint book reading supported the findings reported in Rowe & Goldin-Meadow (2009a) from free play suggesting that there is a relationship between child's and maternal gestural behavior. However, our results confirm this only for pointing, which is a typical scripted behavior in this particular book reading situation.

Furthermore, we analyzed whether and what type of the mothers' gestural behavior is a predictive factor of the child's reported vocabulary development (assessed with a language survey). For this analysis, we contrasted an adult-perspective coding with a child-perspective one. We found that at the age of 14 months, only the child-perspective coding revealed the number of words produced within pointing gestures to be a predictor of later language skills. However, at the age of 18 months, at which children use gesture-speech-combinations in a supplementing manner by themselves (Iverson & Goldin-Meadow, 2005; Rowe & Goldin-Meadow, 2009b), the data revealed a relation between supplementing gesture in the input with the children's reported vocabulary at this age. This finding can be interpreted as the gestural production in children being related to the perception and understanding of gestural input. To put it in other words: children need to produce gesture-speech-combinations in a supplementing manner in order to be able to perceive such combinations in a meaningful way. However, this hypothesis assuming a relationship between expressing semantic aspects in gesture and being able to perceive them in the gestural input has to be tested in experimental settings.

We therefore suggest that the relation of gesture and speech should not only be investigated from the adult-perspective. Instead, there is a need to include the child-perspective into the coding system as the children are not perceiving semantic synchrony as adults do, and the temporal synchrony of gesture and speech might play a rather highlighting role in early language development. We suggest that this highlighting role can be captured by a simple calculation of rather temporal relationship between verbal speech and gestures, specifically: how many words are accompanied by gestural behavior. This calculation is motivated by learning mechanisms suggested in early infancy (Bahrack et al., 2004).

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