Evidence for Referential Expectation in Four-Month-Old Infants

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Abstract

Infants' sensitivity to selectively attend human speech and to process it in a unique way has been widely reported in the past. However, in order to successfully acquire language, one should also understand that speech is a referential symbol system, and that words can stand for other entities in the world. While there has been some evidence showing that young infants can make inferences about the communicative intentions of a speaker, whether they would also appreciate the direct relation between a specific word and its referent, is still unknown. In the present study we tested four-month-old infants to see whether they would expect to find a referent when they hear human speech. Our results showed that compared to other auditory stimulus or to silence, when infants were listening to speech they were more prepared to find some visual referents of the words, but only if the speaker also provided additional referential cues. Thus, our study is the first to report evidence that infants at a very young age already appreciate the symbolic nature of language and that they understand the referential relation between auditory words and physical objects, even if they do not have yet any knowledge about the meanings of words.

Keywords: language; referential expectation; symbol understanding; development.

Introduction

Human language is a special auditory stimulus for which infants show a unique sensitivity, compared to any other types of auditory stimuli. Various studies found that newborns are not only able to distinguish languages they never heard before based on their rhythmical characteristics (Mehler, Jusczyk, Lambertz, Halsted, Bertoncini, et al., 1988; Nazzi, Bertoncini, & Mehler, 1998; Ramus, Hauser, Miller, Morris, & Mehler, 2000), but they can also detect acoustic cues that signal word boundaries (Christophe, Dupoux, Bertoncini, & Mehler, 1994), discriminate words based on their patterns of lexical stress (Sansavini, Bertoncini, & Giovanelli, 1997) and distinguish content words from function words by detecting their different acoustic characteristics (Shi, Werker, & Morgan, 1999). Moreover, they can also recognize words with the same vowels after a 2 min delay (Benavides-Varela, Hochmann, Macagno, Nespor, & Mehler, 2012). In fact, infants are more sensitive to the statistical and prosodic pattern of language than adults, which provides an explanation why acquiring a second language is more difficult in adulthood than during infancy (Kuhl, 2004). In addition to this unique sensitivity to the characteristics of language, infants also show a particular preference for language, compared to other auditory stimuli. For example, infants at the age of 2-months, and even newborns prefer to listen to speech compared to non-speech stimuli, even if the non-speech stimuli retain many of the spectral and the temporal properties of the speech signal (Vouloumanos & Werker, 2004, 2007)

However, in order to successfully acquire a language, one should also understand the direct referential relation between words and the entities they stand for. Thus, in the present study we address this question: *do infants from a very young age perceive speech as a referential symbol system and do they expect to find the referents of the words they hear?*

Experiment 1.

Thirty, 4-month-old infants were tested using a looking time latency paradigm, and were shown videos of a female face, who was either talking in a normal way (Normal Speech Condition), or in a backward way (Backward Speech Condition), or she was silently moving her lips (No Speech Condition), while she was looking at the infant. We selected the backward speech as a control condition for the Normal Speech because even though its auditory characteristics are very similar to those of normal speech, there is evidence that neither infants, nor adults process backward speech similarly to natural languages (Dehaene-Lambertz, Dehaene, & Hertz-Pannier, 2002; Peña, Maki, Kovacic, Dehaene-Lambertz, Koizumi, et. al, 2000) The latency of infants' orienting to the objects was measured as the dependent variable.

Results

We predicted that in the case infants have a referential expectation about language, they would expect to find the referent and therefore orient faster to the object in the Normal Speech than in the Backward Speech or the No Speech condition. This prediction was confirmed by our data. Our results confirm that when infants are presented with a combination of language and eye-gaze, they are faster in finding the referent of speech compared to when they hear non-linguistic stimuli or when they only see the eye-gaze along with the silent movements of the lips. Thus, the combination of speech and eye-gaze already facilitates infants' search for the referent of speech at the age of 4 months. However, since in the stimuli we used an object-directed gaze of the speaker always preceded the appearance of the object, it remains unclear whether without the object-directed eye-gaze we would get the same effect, or the combination of speech and an object-directed gaze is needed. To answer this question, we designed a second experiment, where in addition to the object-directed gaze

trials, we also included trials where the speaker was gazing at the infant during the entire movies. We predicted that in case an object-directed gaze is needed to elicit referential expectation, we would find a significant difference in infants' looking time latency between the object-directed gaze conditions, and the new infant-directed gaze conditions. Additionally, in case we find that a consecutive eye-gaze is necessary to evoke the searching behaviour for the referent, it would be interesting to estimate the power of this factor. To this end, we decided to use *incongruent* object-directed gaze trials as well, i.e. conditions where the direction of the eye-gaze was incongruent with the appearance of the object. The extent to which these trials slow down the searching behaviour of infants indicates the strength of the effect of eye-gaze in eliciting referential expectation.

Experiment 2

In order to clarify these questions, we collected N= 30 participants' data in a second experiment with 3x3 factors, referring to Language (Normal Speech, Backward Speech and No Speech), and Gazing (Congruent Object-Directed, Incongruent Object-Directed and Infant-Directed). The task was the same as in Experiment 1. While infants watched the stimuli, their looking time latency was measured in each trial towards the objects.

Results

The analysis of the different Gaze conditions revealed a strong significant difference between the three levels of Language conditions in the Congruent Object-Directed Gaze condition. In the Incongruent Object-Directed and in the Infant Directed Gaze conditions, however, we found no significant differences.

Post-hoc pairwise tests revealed that infants looked significantly faster at the object in the Congruent Object-Directed Gaze / Normal Speech condition than in the Congruent Object-Directed Gaze /Backward Speech condition.

Our results replicated the results of the first experiment, by showing that infants' orientation towards the visual object is the fastest when they hear normal speech and follow the object-directed gaze of the speaker. Furthermore, the results of the second experiment also gave evidence that the object-directed gaze of the speaker is helpful to find the referent of the speech only if it is preceded by speech.

Conclusion

Confirming our hypothesis, the results of Experiment 1 and 2 showed that infants at the age of 4-months are ready to look for potential referents when they are presented with a combination of speech and a referential gaze of the speaker. In both experiments, looking time latency was the shortest when infants heard normal speech, along with an object-directed gaze of the speaker, which was congruent with the direction of the object. We propose that the shorter

time taken to orient toward the object reflects infants' readiness to find a potential referent of speech, which supports the idea that they already possess an understanding of the referentiality of language.

Our results highlight the fact that speech can be interpreted in different ways, and additional cues are required to choose between these possible interpretations. When a speaker only provides ostensive cues along with the speech (i.e. a direct-eye gaze), the interpretation is restricted to the fact that s/he wants to elicit the attention of the infant. However, when additional referential cues are also provided (i.e. an averted gaze of the speaker), this will establish a referential interpretation of the speech, and infants will be ready to seek for potential referents. We found that infants at a very early age are already able to express signs of these different interpretations when they are exposed to speech and a consecutive eye-gaze of the speaker.

Our findings shed a new light on the early learning mechanisms of infants. The fact that already at this early age infants understand that language is a possible tool to convey messages and transfer knowledge means that they are also ready to learn about the world via their conspecifics. By being predisposed to get information from their social partners, infants can selectively attend to certain stimuli in their environment. Thus, by talking to infants, even if they don't understand the meanings of the words yet, one can effectively draw their attention towards distinct elements of their surroundings and, as a consequence, shape their learning processes, from a very early age on.

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