Infant Behavior and Development 48 (2017) 65–77

Contents lists available at ScienceDirect

Infant Behavior and Development

journal homepage: www.elsevier.com/locate/inbede

Full length article

Social interaction facilitates word learning in preverbal infants: Word–object mapping and word segmentation

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ARTICLE INFO

Keywords:
Word learning
Word–object mapping
Word segmentation
Preverbal infant
Social interaction

ABSTRACT

In natural settings, infants learn spoken language with the aid of a caregiver who explicitly provides social signals. Although previous studies have demonstrated that young infants are sensitive to these signals that facilitate language development, the impact of real-life interactions on early word segmentation and word–object mapping remains elusive. We tested whether infants aged 5–6 months and 9–10 months could segment a word from continuous speech and acquire a word–object relation in an ecologically valid setting. In Experiment 1, infants were exposed to a live tutor, while in Experiment 2, another group of infants were exposed to a televised tutor. Results indicate that both younger and older infants were capable of segmenting a word and learning a word–object association only when the stimuli were derived from a live tutor in a natural manner, suggesting that real-life interaction enhances the learning of spoken words in preverbal infants.

1. Introduction

There is a large body of research attempting to explain how human infants learn spoken language so rapidly and effortlessly despite immature cognitive competence. Previous studies have shown that infants are aware of ambient language while still in the womb (Mehler et al., 1988; Moon, Lagercrantz, & Kuhl, 2013). In other words, they begin to perceive and process speech sounds long before they produce their first word at around the end of the first year. How and when do infants start acquiring words? Broadly speaking, people are required to segment phoneme sequences into words from a continuous speech stream and then associate the words with a meaning in order to build a lexicon. Thus, before developing a vocabulary, infants have to acquire at least two capacities: word segmentation and word–object mapping. Although 4–5-month-old infants already prefer to listen to their own names relative to unfamiliar names (Mandel, Jusczyk, & Pisoni, 1995), more general word learning starts as early as 6 months after birth (Gervain & Mehler, 2010).

Jusczyk and Aslin (1995) tested infants' ability to segment words and revealed that infants acquiring English were able to segment familiar words from continuous speech at around 7 months of age. Additionally, in an English-learning environment infants as young as 6 months of age are able to segment novel words from continuous speech if the word is preceded by highly familiar words like their own names (Bortfeld, Morgan, Golinkoff, & Rathbun, 2005). In comparison, it has been suggested that infants acquiring Japanese exhibit slower development, since there is no evidence of segmentation abilities in this context before 9 months of age (Kobayashi,

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http://dx.doi.org/10.1016/j.infbeh.2017.05.012
Received 7 November 2016; Received in revised form 26 May 2017; Accepted 26 May 2017
Available online 01 June 2017
0163-6383/

Naoi, & Kojima, 2009; Sato, Kajikawa, Sakamoto, & Matsumoto, 2007). There may however be some indirect evidence suggesting development of language abilities at a younger age (Kajikawa & Masataka, 2003). In turn, the age at which acquisition of word–object relations begins is not straightforward. Under tightly controlled conditions, Yoshida, Fennell, Swingley, and Werker (2009) claimed that infants were capable of mapping phonetically similar words and visual referents at 14 months. Gogate (2010) argued that 7-month-old infants already have some capacity for learning word–object relations if the words are distinctive and presented simultaneously with a moving object. Recent research has documented that even 6-month-old infants are able to learn word–object associations when the word is aligned with a prosodic phrase boundary (Shukla, White, & Aslin, 2011). Typically 6-month-old infants already know the meanings of some common nouns, such as "mommy" and "banana," through exposure to the ambient language in their everyday life (Bergelson & Swingley, 2012; Tincoff & Jusczyk, 1999). Although recent work suggests that infants younger than 6 months are able to understand word–object relations in natural settings, little research has examined word learning ability in an ecologically valid setting, for instance, in the presence of an interactive tutor.

Since infants are naturally surrounded by social stimuli from birth and learn about the world from interactions with other people, it is often suggested that social interaction plays a significant role in language development (Kuhl, 2007). Early receptive and expressive vocabulary often includes words heard frequently in social interactions with adults (e.g., mommy, bye, hi) (Ogura, 1999). Mothers often spontaneously provide infants with communicative cues, such as eye contact, infant-directed speech (IDS), calling of their names, and contingent responsiveness (Bornstein, Tamis-LeMonda, Chun-Shin, & Haynes, 2008; Csibra, 2010; Papoušek & Papoušek, 1989). According to studies that measure correlations between mother-specific factors and language development in infants, the presence of such social signals during mother–infant interactions seems to foster language development (Altvater-Mackensen & Grossmann, 2015; Baumwell, Tamis-LeMonda, & Bornstein, 1997; Elsabbagh et al., 2013; Gros-Louis, West, & King, 2014; Hirsh-Pasek et al., 2015; Hsu & Fogel, 2001; Liu, Kuhl, & Tsao, 2003; Miller & Gros-Louis, 2013; Nicely, Tamis-LeMonda, & Bornstein, 1999; Rollins, 2003; Tamis-LeMonda, Bornstein, & Baumwell, 2001; Weisleder & Fernald, 2013). Similarly, correlations between infants' responsiveness to social stimuli and their later language skills were found to be significant; language development in infants relies heavily on the social capacities of not only parents but also the infants themselves (Altvater-Mackensen & Grossmann, 2015; Brooks & Meltzoff, 2005; Mundy & Gomes, 1998).

Kuhl, Tsao, and Liu (2003) conducted the first study to evaluate the role of live interaction in foreign-language phonetic learning in 9–10-month-old infants. They demonstrated how infants learned a non-native phonetic contrast only from a live tutor and not from a prerecorded, televised tutor, emphasizing the importance of social interaction for this task. Several studies have revealed that each social signal has a role in facilitating early speech learning. For instance, it is well recognized that adult contingent responsiveness increases infant vocalizations (Dunst, Gorman, & Hamby, 2010; Goldstein, King, & West, 2003; Goldstein & Schwade, 2008; Pelaez, Virues-Ortega, & Gewirtz, 2011; Ramey, Hieger, & Klisz, 1972; Rheingold, Gewirtz, & Ross, 1959; Weisberg, 1963). In terms of word learning, a facilitation effect has been confirmed for a variety of social signals including IDS (Singh, Nestor, Parikh, & Yull, 2009), eye contact (Wu, Tummeltshammer, Gliga, & Kirkham, 2014), contingent responsiveness (Roseberry, Hirsh-Pasek, & Golinkoff, 2014), and touch (Seidl, Tincoff, Baker, & Cristia, 2015). In addition, Gogate, Bolzani, and Betancourt (2006) claimed that maternal use of temporal synchrony between naming of an object and object movement during the exposure session predicted 6–8-month-old infants' learning of word–object relations. These findings indicate that infants benefit richly from social factors.

The fact that infants and toddlers learn less from video demonstrations than from equivalent live demonstrations is called the video deficit effect (Anderson & Pempek, 2005; Barr, 2010). The video deficit effect is apparent until around 2–3 years of age depending on task complexity in various situations such as imitation tasks (Barr & Hayne, 1999; Barr, Muentener, & Garcia, 2007; Barr, Muentener, Garcia, Fujimoto, & Chávez, 2007; Hayne, Herbert, & Simcock, 2003; Krcmar, 2010; Nielsen, Simcock, & Jenkins, 2008), object search tasks (Deocampo & Hudson, 2005; Schmitt & Anderson, 2002), and word learning tasks (DeLoache et al., 2010; Krcmar, 2010; Krcmar, Grela, & Lin, 2007; Linebarger & Walker, 2005; Robb, Richert, & Wartella, 2009). However, less is known about the video deficit effect on preverbal infants, especially for infants under the age of 6 months despite high potential for the strong tie between social factors and early word learning. Some studies have indicated that there is no video deficit for infants younger than 1 year. Barr, Muentener, and Garcia (2007), for example, examined 6-, 12-, 15-, and 18-month-olds' action imitation and found that 6-month-old infants imitated actions equally well from live and video demonstration, while older infants demonstrated a video deficit effect to some extent. For word learning, Krcmar (2010) revealed that 13–20-month-olds, but not 6–12-month-olds or 21–24-month-olds, learned words more effectively from the live mother than from the televised mother, suggesting that the video deficit is not present for preverbal infants. In addition, unlike 12–24-month-olds, 10-month-old infants do not appear to rely on social cues (i.e., speaker's gaze) when learning novel words (Pruden, Hirsh-Pasek, Golinkoff, & Hennon, 2006). However, these studies used the same tasks with infants from a wide age range and therefore the tasks may well have been too difficult for preverbal infants. There are studies that employed age-appropriate tasks for preverbal infants and found differences in their language learning from a live and televised demonstration as discussed earlier (Kuhl et al., 2003). Furthermore, both behavioral and neural findings indicate that preverbal infants respond differently to a live and televised representation (Johnson et al., 2012; Shimada & Hiraki, 2006). However, the effect of live interactions on word learning for preverbal infants still remains controversial. Very little is known about developmental changes within the first year of life regarding the relation between word learning and social interactions.

The choice of methodology for testing infants' naming abilities also has an impact on their overall performance (Werker & Curtin, 2005; Yoshida et al., 2009). In this study, we used the modified head-turn preference paradigm (Kemler Nelson et al., 1995) used in previous studies (Hakuno, Omori, Yamamoto, & Minagawa-Kawai, 2012; Imafuku, Hakuno, Uchida-Ota, Yamamoto, & Minagawa, 2014) to test infants' word–object mapping ability. After short-term exposure to a novel word–object pairing, a visual stimulus appears either on the left or right side of the display in each trial along with an auditory stimulus. An experimenter observes the