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The Nature of Early Word Comprehension: Symbols or Associations?

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Abstract

The current study investigated comprehension of object labels in young children. Eight- and 14-month olds were presented with pairs of pictures (e.g., dog and ball) to establish infants' initial looking preferences and then children heard a linguistic label (e.g., *dog*). Only 14-month-olds reliably increased looking to the referents after hearing the labels relative to their initial preference, which suggests that 14-month-olds were familiar with the word-object relations used in the current task. When the referent was paired with the source of the auditory information (e.g., dog paired with a person) and children heard a label (e.g., *dog*), 8-month-olds increased looking to the person relative to their initial preference and 14-month-olds' comprehension of the word-object relations dropped to chance. These findings are consistent with the notion that children's early word comprehension is associative in nature and questions whether young children understand the symbolic nature of words.

Keywords: Cognitive Development, Attention, Language Acquisition, Psychology, Human Experimentation.

Introduction

By 6- to 7-months of age, children begin recognizing familiar words embedded within the speech stream (Jusczyk & Aslin, 1995) and around 8-9 months of age infants (according to parental reports) begin associating words with objects in the environment (Fenson, et al., 1994). Although word learning during the first year is often described as a slow and laborious process, children become very efficient at learning words during the second and third years of life. For example, under certain conditions, 12- to 14-month-old children ably associate words with objects (Woodward & Hoyne, 1999; Woodward, Markman, & Fitzsimmons, 1994), and extend these words to other objects in the category (Campbell & Namy, 2003). By 14- to 15-months of age, children can learn words by simply detecting correlations between words and objects in the environment (Schafer & Plunkett, 1998; Werker, Cohen, Lloyd, Casasola, & Stager, 1998), and shortly after, children can fast map words to objects in the environment (Carey & Bartlett, 1978; Markson & Bloom, 1997; see Woodward & Markman, 1998, for a review).

Although the developmental changes that occur in early word learning are well documented, the underlying nature of children's early word comprehension is not fully understood. For example, adults understand that words *refer* or *stand for* objects and categories and differ from sounds that they simply *go with* objects (e.g., a four-legged pet can be substituted by the word *dog* but not by a barking sound). Do young infants at the onset of word learning understand the referential and symbolic nature of words or are words better understood as features that are associated with objects? From one perspective it has been argued that by 9-months of age children already have assumptions that words but not sounds refer to categories (e.g., Waxman, 2003), and it would be difficult if not impossible for word learning to begin without children making assumptions that words are symbols that refer to objects and categories (e.g., Golinkoff, Mervis, & Hirsh-Pasek, 1994).

From a very different perspective, children's assumptions about words are better understood as features that are associated with objects. In particular, it has been argued that children do not perceive words as symbols or semantic markers, rather, words affect behavior on a variety of cognitive tasks by influencing the overall similarity of compared entities (Sloutsky & Fisher, 2004;

Sloutsky & Lo, 1999). By defining words as another feature of an object, as opposed to a symbol or semantic marker, it is not surprising that labels are also affected by perceptual similarity: Children assume that phonologically similar labels are linked to visually similar entities (Fisher & Sloutsky, 2004). Although the studies reported above tested older children, they challenge the idea that even early in development children expect words to refer to objects and categories.

If early in development words are features that are associated with objects (rather than symbols denoting objects), then children's behavior on a word comprehension task should best be predicted by the statistical regularities found in the environment. Because most of the words come from a particular source (i.e., human being), young children should exhibit knowledge of this correlation, and this correlation should affect early word comprehension. In particular, even when children demonstrate familiarity with word-object relations, they should have difficulty inhibiting their attention to stronger correlations (i.e., source of auditory input).

The goal of the current study was to determine whether young children's early word comprehension is better understood as symbols that *stand for* objects in the environment or as features that are associated with objects. The current study employed a preferential looking procedure to assess children's word comprehension at 8- and 14-months of age (see Golinkoff, Hirsh-Pasek, Cauley, & Gordon, 1987; Reznick, 1990; Schafer & Plunkett, 1998 for similar procedures). For half of the trials children were presented with two possible referents (e.g., dog and ball). After establishing the initial saliency of the pictures, children heard a label for one of the referents (e.g., *dog*). Comprehension was assessed by children's relative looking to the referent after hearing the label compared to their initial preference. The remaining trials consisted of pitting the source of the auditory input against the referent. For example, children on these trials may have seen a person paired with a dog and heard the label *dog*.

If children have some understanding of the word *dog* and understand the symbolic nature of the word then they should have no difficulty inhibiting their attention to the source of the label (two-dimensional image of a person) and look to the referent, with looking to the referent exceeding their initial preference. In other words, if children have assumptions that words stand for objects, linguistic input should direct children's attention to objects, not to the source of the auditory input (see Balaban & Waxman, 1997; Baldwin & Markman, 1989, Xu, 2002, for similar claims). However, if words are simply associations for young children then they should look to the image that has the strongest correlation with the auditory stimulus. Here, children should increase looking to the person relative to their initial preference.

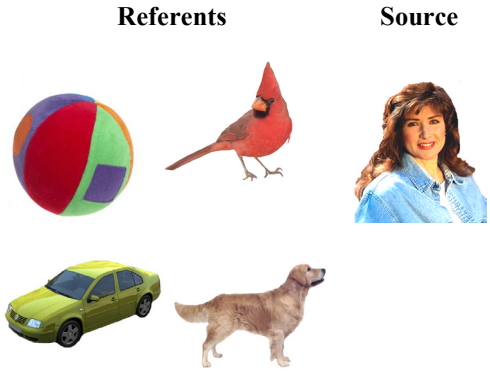
Method

Participants Twenty-five 8-month-olds (10 boys and 15 girls, M = 250 days, SD = 7 days) and 23 14-month-olds (13 boys and 10 girls, M = 456 days, SD = 57 days) participated in this experiment. Parents' names were collected from local birth announcements, and contact information was obtained through local directories. A majority of infants were Caucasian, and all children had no auditory or visual deficits, as reported by parents. Fourteen children were excluded due to fussiness.

Apparatus Infants were seated on parents' laps approximately 100 cm away from a 152 cm x 127 cm projection screen, which was located approximately 5 cm above the infant's eye level. A Sony DCR-TRV40 camcorder was used to capture infants' fixations and was projected to one of two Dell flat panel monitors in the observation room. An NEC GT2150 LCD projector was mounted on the ceiling approximately 30 cm behind the infant (130 cm away from the projection screen). Two Boston Acoustics 380 speakers were 76 cm apart from each other and mounted in the wall. The speakers and camcorder were concealed by black felt and located directly below the projection screen. Two small lights were located behind the infant to ensure that the room was dimly lit throughout the entire procedure. In an adjacent room, a Dell Dimension 8200 computer with *Presentation* software was used to present stimuli to the infants, as well as to record the onset and offset of infant's visual fixations. Fixations were recorded online by pressing one of two buttons on a 10-button USB game pad when infants were looking at the stimuli and releasing the buttons when infants looked away from the stimuli. A second Sony DCR-PC120 camcorder was used to record the video stream of the infant from the monitor indicated above, as well as to record the image of the stimulus presentation on a second Dell flat panel monitor. This split screen recording was used to establish interrater reliability.

Stimuli The visual stimuli consisted of pictures of common animals and objects (referents) and a picture of a woman (source of auditory input), see Figure 1 for visual stimuli. Each image was presented at approximately 36 x 36 cm in size and stimuli were presented in pairs with approximately 100 cm between the stimuli. The auditory stimuli consisted of four basic-level labels. Each label (*ball*, *bird*, *car*, and *dog*) was spoken by a female experimenter in infant-directed speech. The labels were recorded as high quality 44.1 kHz wav files and were presented by the computer at 65-68 dB.

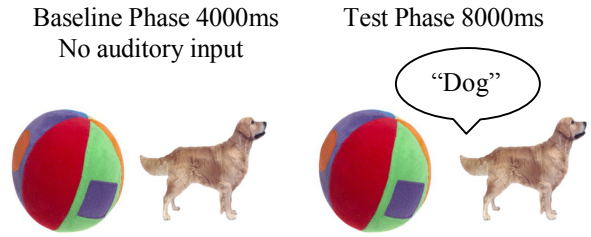
Figure 1. Visual stimuli presented to infants



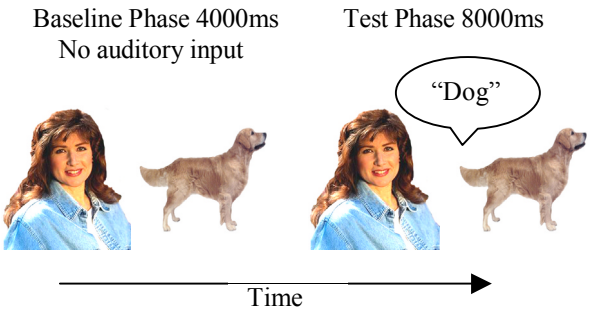
Procedure The overall procedure consisted of 24 trials. Twelve of the trials were *reference* trials, and 12 of the trials were *source* trials. In the 12 referential trials, children were presented with two possible referents (e.g., dog and ball) and children heard one of the labels (e.g., *dog*). The source trials consisted of pairing a referent with the source of the auditory input. For example, children may have seen a dog paired with a woman and heard *dog*. Every trial had two phases: a baseline phase and a testing phase, see Figure 2 for an overview of the procedure. In the baseline phase children were presented with two stimuli and no auditory input was provided. The baseline phase served as a measure of initial saliency.

Figure 2. Overall Procedure

(a) Reference Trials (12 trials)



(b) Source Trials (12 Trials)



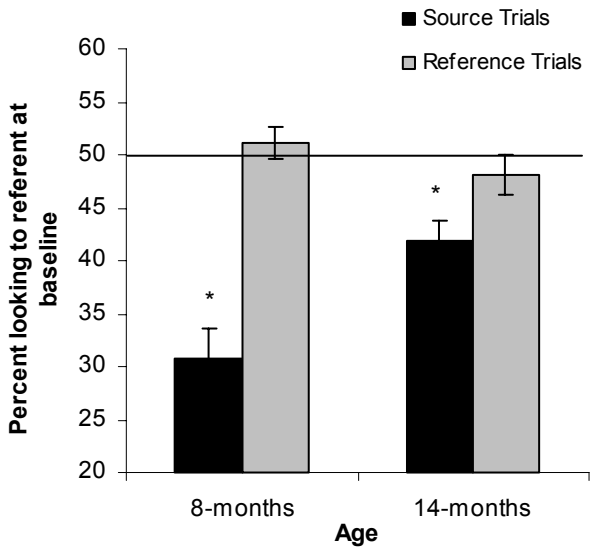
After assessing the saliency of the visual stimuli, children moved to the testing phase. The testing phase was similar to baseline except that children heard one of the labels. The label was presented twice on each test trial, once at the onset of the test trial and the second time at 4000 ms. Accumulated looking to each object (referent and foil) was recorded during both baseline and test. Twenty-five percent of the trials were coded offline by experimenters who were blind to the auditory and visual components presented to infants. No differences were found between subjects coded on- and offline.

If children are familiar with the word-object relations then children should accumulate more looking to the referent after hearing the label (test phase) in the reference trials compared to their initial preference (baseline phase). Furthermore, if children understand that words refer to objects then pairing a referent with the source of auditory input should either facilitate comprehension or have no effect, with children continually looking at the referent.

Results and Discussion

Initial analyses focused on children's looking to the referent prior to hearing labels (baseline). A percent looking to the pre-labeled referent was calculated on each trial (looking to referent during baseline/overall looking to both pictures during baseline), and two separate means were calculated: One mean for the reference trials and one mean for the source trials. As can be seen in Figure 3, both the 8- and the 14-month-olds had no initial preference to look to the referent before hearing the labels on the reference trials, *p*s > .1. In contrast, children looked significantly below 50% to the referent on the source trials, *t*s > 4, *p*s < .001, which suggests that when the referent was paired with the source children initially had a strong preference to look to the source. No further analyses were conducted on baseline trials.

Figure 3. Saliency of stimulus pairs at baseline across age and trial types.

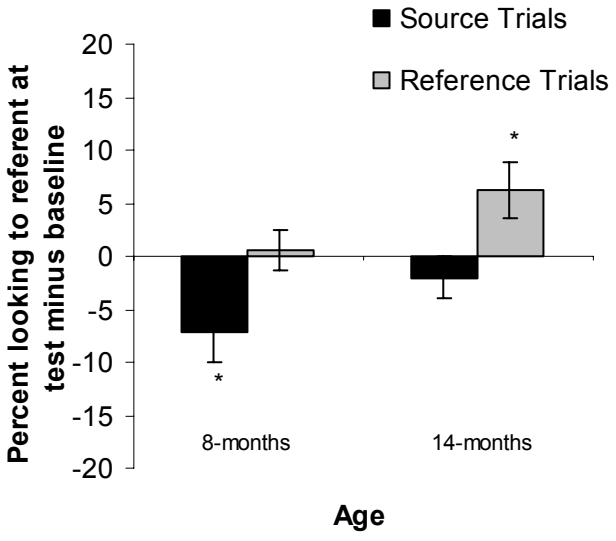


Note: "*" < 50%, $p < .001$. Error bars represent standard errors

The primary analyses focused on children's looking to the referent after hearing the labels across the two trial types. However, given children's initial preferences during baseline, we deemed it necessary to control for these preferences in the following analyses. A difference score was calculated on each trial by subtracting the percent looking to the referent at baseline from the percent looking to the referent at test. For each child, a mean was calculated across the 12 reference trials and a separate mean was calculated for the 12 source trials. Thus, difference scores greater than 0 reflect increased looking to the referent relative to baseline looking and difference scores less than 0 reflect decreased looking to the referent relative to baseline (or increased looking to the source on source trials). Trials where children did not accumulate at least one look at baseline and one look at test were eliminated and did not influence the mean. Approximately 12% of the trials were eliminated.

Difference scores by trial type and age are presented in Figure 4. As can be seen in Figure 4, participants increased looking to the referents on the reference trials more than they increased looking to the referents on source trials. Furthermore, 14-month-olds increased looking to the referents more than the 8-month-olds. The difference scores were subjected to a 2 (Trial Type: Reference, Source) x 2 (Age: 8-months, 14-months) ANOVA with Trial Type as a repeated measure. The analysis revealed a main effect of Trial Type, F (1, 46) = 12.62, $p < .001$, and a main effect of Age, F (1, 46) = 4.72, $p < .05$. The interaction did not approach significance, $p = .91$.

Figure 4. Comprehension compared to chance across age and trial types.



Note: "*" difference score <> 0%, $p < .001$. Error bars represent standard errors

The nonsignificant Trial Type x Age interaction suggests that both age groups responded similarly to the labels across the Trial Types, however, it was also important to compare children's comprehension to chance. As can be seen in Figure 4, 8-month-olds on the source trials significantly increased looking to the source (or away from the referent) after hearing the labels, t (24) = 2.60, $p < .05$. This finding is not surprising given that these children did not demonstrate comprehension of the labels on the reference trials. In contrast, 14-month-olds did demonstrate comprehension of the object labels: Looking to the referents on the reference trials exceeded 0, t (22) = 2.37, $p < .05$. However, comprehension of these "comprehended" labels dropped to chance when the referent was paired with the source of auditory input, which suggests that these children had difficulty inhibiting their attention to the source of the auditory stimulus.

Follow up analyses focused on 14-month-olds' individual responses across the two trial types. These analyses are important for demonstrating that the decrease in looking to the referent on the source trials did not stem from several outliers. On the reference trials, 83% of children increased looking to the referent compared to their initial preference (i.e., percent looking to referent at test > percent looking to referent at baseline), which was the dominant pattern of response, χ^2 (1, N = 23) = 9.78, $p < .005$, and is comparable to parental reports at this age (Fenson, et al., 1994). In contrast, only 35% of the children increased looking to the referent on the source trials, which was significantly less than this proportion on reference trials, χ^2 (1, N = 23) = 36.62, $p < .001$. Therefore, differences between the reference and source trials were generated by different distributions rather than by a small number of outliers.

General Discussion

The current study revealed several important findings concerning children's early word comprehension. First, the source of auditory input is very salient for children, and not surprisingly, children associated human speech with the source of auditory input (person) well before acquiring the specific word-object associations: Recall that 8-month-olds significantly increased looking to the source after hearing the labels, whereas, they responded at chance on the reference trials. Second, developmental differences were found with only 14-month-olds demonstrating comprehension of the word-object associations tested in the current study. These findings are consistent with previous research using a comparable word comprehension task (Reznick, 1990; Reznik & Goldfield, 1992), consistent with parental reports (Fenson, et al., 1994), and consistent with word learning tasks where young children often have difficulty learning novel words in a laboratory setting (e.g., Werker et al., 1998). More importantly,

however, the current study demonstrates that although older children have acquired more word-object associations, as indicated by only the 14-month-olds demonstrating comprehension on the reference trials, the underlying nature of children's word knowledge does not appear to change between 8- and 14-months of age: Both age groups had difficulty inhibiting their attention to source of the auditory input.

Why did children look to the person after hearing the labels? From a socio-pragmatic perspective, it could easily be argued that children increased looking to the person because they were trying to detect social cues such as eye gaze or pointing that could potentially constrain the words' meanings. While this explanation is consistent with various theories of how children acquire early word meaning (see Baldwin & Moses, 2001, for a review), it is uncertain why 14-month-olds would need to rely on social cues if they have already acquired knowledge about the words.

An alternative explanation is that children's looking to the source reflects the notion that, for young children, words are simply features that are associated with objects (Sloutsky & Lo, 1999). From this perspective, children should be influenced by the perceptual similarity of the labels (cf., Fisher & Sloutsky, 2004), and the current study demonstrates that early word comprehension is also affected by statistical properties. Eight-month-olds in the current study demonstrated that the correlation between human speech and humans is stronger than the word-object associations presented in the current study. More importantly, however, is the finding that, even when children have some knowledge of the word-object associations, comprehension is still affected by the inability to inhibit attention to stronger correlations. Of course, it could be counter argued that the results could have been different if words were presented in a syntactic frame rather than in isolation (e.g., Namy & Waxman, 2000). While present research does not address this possibility, we have preliminary evidence suggesting that the reported effects do not disappear even when words are presented in a syntactic frame.

The findings of the current study are not consistent with the claim that children understand that words are symbols that stand for objects and categories. In particular, if children have assumptions that words refer to objects and categories, then children should direct their attention to potential referents after hearing words. However, most of the studies supporting this claim either did not give children the opportunity to look to the source or did not assess looking to the source relative to the referent (but see Baldwin & Markman, 1989). The current study demonstrates that when children are given the opportunity to look to source of the auditory input, the relative looking to the referent decreases considerably. This finding not only has implications for conceptualizing word meaning in young children, but may also have broader implications concerning how and why language influences cognitive growth: Can labels facilitate the formation of categories if children have not acquired the notion that words refer?

The current study may also highlight the difficulty of children's early word learning. In particular, for children to learn a word's meaning they must inhibit their attention to the source of the auditory input before they can detect that the word is correlated with an object. Thus, the current study makes a non-trivial prediction: Early in development it should be easier for children to associate a sound with an object (e.g., dog bark with a dog) than a word with an object because in the former children's attention should be directed to the source, which is also the object that *goes with* the auditory stimulus. At the same time it seems likely that word learning may be facilitated by making objects more salient. In particular, there is evidence that infants are more likely to associate words with objects when objects move (Werker et. al., 1998) or when a word is associated with the most salient object in a set (Hollich, Golinkoff, & Hirsh-Pasek, 2000). These manipulations may help children acquire word-object associations by directing their attention away from the source of the auditory input. While this hypothesis needs to be tested, it would further highlight the attentional and associative components of early word comprehension.

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