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Brief article

Words (but not Tones) facilitate object categorization: Evidence from 6- and 12-month-olds

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Abstract

Recent studies reveal that naming has powerful conceptual consequences within the first year of life. Naming distinct objects with the same word highlights commonalities among the objects and promotes object categorization. In the present experiment, we pursued the origin of this link by examining the influence of words and tones on object categorization in infants at 6 and 12 months. At both ages, infants hearing a novel word for a set of distinct objects successfully formed object categories; those hearing a sequence of tones for the same objects did not. These results support the view that infants are sensitive to powerful and increasingly nuanced links between linguistic and conceptual units very early in the process of lexical acquisition.

Keywords: Infancy; Categorization; Object naming

Questions concerning the relation between linguistic and conceptual organization have long occupied a central position in the cognitive sciences. Recently, considerable attention has been devoted to discovering the origin of this relation in infants and toddlers. Research in this arena has focused primarily on early word-learning. This is an

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apt focus because at its core, learning a word involves establishing a relation between a linguistic unit (the word) and a conceptual unit (the concept to which the word refers). The key developmental question is when words begin to carry conceptual force, and how early in the process of word-learning they begin to influence infants' representations of individual objects and the relations among them (Balaban & Waxman, 1997; Booth & Waxman, 2003; Fulkerson & Haaf, 2003; Namy, 2001; Namy & Waxman, 1998; Roberts & Jacob, 1991; Waxman & Booth, 2003; Waxman & Braun, 2005; Waxman & Markow, 1995; Woodward & Hoyne, 1999; Xu, 1999, 2002).

There is now robust evidence that words and conceptual organization are linked within the first year of life. Even at 9–12 months of age, when infants have just begun to produce their first words, naming has powerful conceptual consequences. Applying the same name to distinct objects (e.g., four different animals) highlights commonalities among the objects and supports infants' formation of an inclusive category (e.g., animal). This phenomenon was first documented in 12-month-olds using a novelty-preference task (Waxman & Braun, 2005; Waxman & Markow, 1995). Infants were familiarized to four different category exemplars (e.g., four animals) in conjunction with infant-directed speech. In the experimental conditions, an experimenter introduced these using a novel name (e.g., "See the *fauna*?"); in the No Word control condition, she introduced no novel words (e.g., "See here?"). At test, the experimenter introduced a new object from the now-familiar category (e.g., another animal) and an object from a novel category (e.g., a vehicle), saying, "See what I have?"

The results reveal a powerful effect of naming on object categorization. Infants hearing novel words successfully formed categories, as witnessed by their reliable preference for the novel test object; those in the No Word control condition did not. Moreover, recent evidence reveals that by the close of the first year, naming supports the acquisition of novel categories comprised of entirely novel objects (Booth & Waxman, 2002; Fulkerson & Haaf, 1998, 2006) and also promotes the strength of object categories as an inductive base (Graham, Kilbreath, & Welder, 2004; Welder & Graham, 2001, 2006).

Additional research has considered whether the effect of naming on infants' categorization stems specifically from the presentation of novel words, or is the consequence of a more general, attention-engaging function associated with auditory stimuli. To address this issue, researchers have compared the effects of novel words vs. non-linguistic stimuli on infant categorization. For example, Balaban and Waxman (1997) compared the influence of novel words vs. novel tone sequences on 9-month-olds' object categorization. Infants viewed a series of pictures representing one object category (e.g., rabbits) in conjunction with an auditory stimulus that emanated from a hidden speaker. In the Word condition, this stimulus was a naming phrase (e.g., "a rabbit"). In the Tone condition, this stimulus was a sine-wave tone (matched to the naming phrase in amplitude, duration and pause length). Infants in the Word condition successfully formed object categories; those hearing tones did not. Subsequent work with a broader range of stimuli has extended this finding: words (including content-filtered words) promoted successful categorization, but non-linguistic sounds (including tones, melodies, mechanical sounds, and even mouth sounds) failed to do so (Balaban & Waxman, 1997; Fulkerson & Haaf, 2003; Woodward & Hoyne, 1999).

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Together, these results suggest that a link between words and concepts is in place quite early. As soon as infants say their first words, there is something special about words: they interpret words, but not other non-linguistic sounds, as inherently connected to meaning. What remains unclear, however, is the origin of this link (Waxman, 1998; Waxman & Lidz, 2006). We know that newborns are especially attuned to human speech (Vouloumanos & Werker, 2004), but this leaves open the question of when infants begin to interpret words as relevant to meaning. Might such a link be available when infants first begin to identify words reliably from the speech stream? And if so, is this early link specific to words, or does it emerge from a more general attention-engaging function associated with auditory stimuli?

We designed the current experiment to address these questions, adapting the novelty-preference paradigm to compare the influence of words and tone sequences on object categorization in infants at two strategically selected ages. We opened our developmental window at 6 months. There are several indications that this is the point at which infants are poised to make their first forays into mapping words to meaning. In particular, they reliably distinguish open-class (content) from closed-class (function) words, and prefer listening to the former (Gomez, 2002; Shi & Werker, 2003); they are able to reliably identify some familiar content words within fluent speech (Mandel-Emer, 1997); and they begin to map a small set of content words (e.g., 'mommy', 'daddy'), to their referents (Tincoff & Jusczyk, 1999). At the same time, infants at 6 months are far from proficient in word-learning. There are several essential developmental milestones not yet in their repertoires. Notably, it is not until 7 months that infants' begin to babble the speech sounds characteristic of their ambient language (Oller, 1980; Oller & Lynch, 1992). Moreover, it is not until 8 months that infants come to recognize the stress patterns typical of words in their ambient language (Johnson & Jusczyk, 2001; Houston, Jusczyk, Kuijpers, Coolen, & Cutler, 2000); it is not until 9 months that they come to recognize phonemic categories that are specific to their ambient language (Cheour et al., 1998; Werker & Tees, 1984; Werker & Lalonde, 1988); and it is not until 14 months that they are able to recruit their *sensitivity* to phonemic contrasts (e.g., 'bin' vs. 'din') as they map words to meaning (Fennell & Waxman, 2006; Werker, Fennell, Corcoran, & Stager, 2002). It is therefore an open question whether infants at this developmental juncture would interpret novel words as inherently connected to meaning and reference. We also included infants at 12 months to anchor the results of the current paradigm with infants for whom the link between words and concepts has been robustly demonstrated (Fulkerson & Haaf, 1998, 2006; Waxman & Braun, 2005; Waxman & Markow, 1995).

Based on previous work, our predictions for 12-month-olds were clear: novel words (but not tone sequences) should support the establishment of object categories (Balaban & Waxman, 1997; Waxman & Markow, 1995; Fulkerson & Haaf, 1998, 2003, 2006). At issue is the performance of the 6-month-olds. One possibility is that for these young infants, words and tones will carry the same force. If this is the case, then infants should perform comparably in the context of words and tones (either successfully establishing object categories, or failing to do so). But it is also possible that infants at this developmental juncture are already sensitive to the distinct

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conceptual force of words. If this is the case, then infants hearing words (but not those hearing tones) will successfully form object categories.

1. Method

1.1. Participants

Participants included 64 six-month-olds (25 female) averaging 185.0 days in age ($SD = 7.0$) and 64 12-month-olds (38 female) averaging 364.0 days in age ($SD = 14.5$). Infants were recruited from county birth records and were predominantly from white, middle-class families. All participating infants were full-term, healthy, and acquiring English as their native language. Eleven additional infants were excluded: equipment failure (4), parental/sibling interference (2), fussiness (2), experimenter error (1), obstructed view of infant (2).

1.2. Stimuli

1.2.1. Visual stimuli

Twenty slides of line-drawn dinosaurs and fish were produced to form two familiarization sets of eight stimuli each and two test sets of two stimuli each (see Fig. 1). Within each familiarization set, stimuli varied in color; within each test set, stimuli were matched in color. Stimuli were outlined in black, filled with a solid color, and projected to an average angular size of 13.3 by 9.0 degrees onto a white screen.

1.2.2. Auditory stimuli

Auditory stimuli included two sets of naming phrases ("Oh look, it's a *toma*/*modi*. Do you see the *toma*/*modi*?") and two sequences of pure tones (400 and 800 Hz). Naming phrases were spoken by a female in the infant-directed speech register and recorded for presentation. Tone sequences were created to match the naming phrases in timing, duration (3.4 s), and volume (92 dB).

1.3. Apparatus

Infants sat on a parent's lap in a gray three-sided booth. One wall of the booth contained two 18 by 18 cm screens (with 12 cm of separation) centered 61 cm from infants' eye level. Visual stimuli were displayed via slide projector. Auditory stimuli were presented through a speaker hidden 58 cm below the midpoint of the screens. Infants were videotaped through a 6 cm hole located 11 cm below the projection screens.

1.4. Procedure

Each infant participated in a novelty-preference task that included a familiarization phase and a test phase (see Fig. 1). Parents were blind to the hypotheses and were instructed not to influence their infant's attention in any way.

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Trial	Word	Tone	Left Screen	Right Screen
Familiarization 1	Look at the toma! Do you see the toma?	---- -- -- ---- -- --- --- --- ----		
Familiarization 2	Look at the toma! Do you see the toma?	---- -- -- ---- -- --- --- --- ----		
Familiarization 3	Look at the toma! Do you see the toma?	---- -- -- ---- -- --- --- --- ----		
Familiarization 4	Look at the toma! Do you see the toma?	---- -- -- ---- -- --- --- --- ----		
Familiarization 5	Look at the toma! Do you see the toma?	---- -- -- ---- -- --- --- --- ----		
Familiarization 6	Look at the toma! Do you see the toma?	---- -- -- ---- -- --- --- --- ----		
Familiarization 7	Look at the toma! Do you see the toma?	---- -- -- ---- -- --- --- --- ----		
Familiarization 8	Look at the toma! Do you see the toma?	---- -- -- ---- -- --- --- --- ----		
Test				

Fig. 1. A representation of the stimuli and procedure for each condition.

1.4.1. Familiarization phase

Infants were presented with eight different exemplars from the same category (e.g., dinosaurs), one at a time, in random order, for 20 s each. The lateral position of the stimulus was determined randomly on the first trial and alternated thereafter. Half the infants at each age were randomly assigned to the Word or Tone condition. In the Word condition, infants heard a naming phrase as they viewed the stimuli; in the Tone condition, infants heard a sequence of pure tones. In both conditions, the auditory stimulus was introduced during the first 4 s of each trial and once again approximately 3 s later. Stimulus set and auditory stimulus were counterbalanced.

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1.4.2. Test phase

In both conditions infants viewed two stimuli: a new exemplar from the now-familiar category (e.g., another dinosaur) and an exemplar from a novel category (e.g., a fish). These were presented side-by-side in silence. The test phase began with infants' first visual fixation to one of the stimuli and lasted 10 s. Test stimulus set and the lateral position of the stimuli were counterbalanced.

1.4.3. Coding

A trained observer, blind to the hypotheses and condition assignment, coded infants' visual fixations. Twenty-five percent of infants in each age and condition were re-coded by an independent observer. Reliability between observers was $r = .96$ during familiarization and $r = .88$ during test.

2. Results

2.1. Familiarization phase

We submitted infants' total accumulated looking time during familiarization to an Age × Condition ANOVA. A significant effect of Age, $F(1,124) = 31.67$, $p < .001$, $prep = .997$, $d = .99$, revealed that 12-month-olds ($M = 115.6$ s, $SD = 18.1$ s) accumulated more looking than did 6-month-olds ($M = 93.8$ s, $SD = 26.0$ s). In addition, the Age × Condition interaction was significant, $F(1,124) = 7.66$, $p = .007$, $prep = .959$, $d = .49$, indicating that with age, infants showed more interest in objects presented with words than objects presented with tones.

2.2. Test phase

To measure categorization, we calculated a novelty-preference score for each infant, dividing looking to the novel-category exemplar by total looking. If infants formed a category, then they should reveal a novelty-preference score greater than chance (.50). We therefore compared performance in each age group and condition to this level of responding.

As predicted, 12-month-olds in the Word condition demonstrated a reliable novelty-preference, ($M = .59$, $SD = .18$), $t(31) = 2.89$, $p = .007$, two-tailed, $prep = .959$, $d = 1.02$, but those in the Tone condition performed at chance, ($M = .53$, $SD = .14$), $t(31) = 1.32$, $p = .20$, $prep = .724$, $d = .47$. Remarkably, 6-month-olds demonstrated the same effect. Infants in the Word condition demonstrated a reliable novelty-preference ($M = .63$, $SD = .19$;) $t(31) = 3.95$, $p < .001$, $prep = 1.00$, $d = 1.40$, but those in the Tone condition performed at chance ($M = .54$, $SD = .20$); $t(31) = 1.05$, $p = .30$, $prep = .645$, $d = .38$.

We next submitted infants' novelty-preference scores to an Age × Condition ANOVA. A significant effect of Condition, $F(1,128) = 5.92$, $p = .016$, $prep = .935$, $d = .43$, revealed that infants in the Word condition ($M = .61$, $SD = .19$) showed reliably higher novelty-preference scores than did infants in the Tone condition

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($M = .54$, $SD = .17$). There were no other main effects or interactions ($ps > .45$). Thus, at both 6- and 12-months of age, words served as a more powerful impetus than tones in the establishment of object categories.

A subsequent analysis of individual infants' performance provides additional evidence that by 6 months, novel words have conceptual consequences that are not observed with tone sequences. We tabulated the number of infants in each age and condition with novelty-preference scores above .50. We then used the binomial probability distribution to determine whether this number differed from chance expectations (16 of 32 infants). At 12 months, 24 infants in the Word condition revealed a novelty-preference ($p = .007$, two-tailed); only 17 did so in the Tone condition ($p = .86$). At 6 months, 25 infants in the Word condition exhibited a novelty-preference ($p = .002$); only 20 did so in the Tone condition ($p = .22$). This suggests that results of the main parametric analyses reflect tendencies that are characteristic of most individuals. At both 6- and 12-months of age, words, but not tones, support the establishment of object categories.

3. Discussion

Previous work has documented that by the time infants begin to produce their first words, they are sensitive to a link between words and the concepts to which they refer. Present results reveal that infants are sensitive to this link as early as 6 months and suggest that this sensitivity is tied specifically to words, rather than to general attention-engaging properties associated with sound. To the best of our knowledge, this constitutes the earliest documentation to date of a link between linguistic units (words) and conceptual units (object categories), and suggests that this link is available to guide infants' earliest efforts to map words to meaning.

These results provide insight into the capacities of infants as they enter the process of word-learning. Characterizing these capacities has been the focus of considerable recent debate. Some have argued that early word-learning is the product of a general associative mechanism, that infants' first words are acquired without the benefit of any guiding expectations, and that it is only after infants have gained a substantial productive lexicon that they become sensitive to links between linguistic and conceptual units (Roberts, 1997; Smith, 1999; Smith, Colunga, & Yoshida, 2003). Others have argued that words hinder infants' ability to form categories (Gogate & Bahrick, 2001; Gogate, Bahrick, & Watson, 2000; Robinson & Sloutsky, 2006).

We have argued for a very different view, asserting that infants are guided from the start by powerful and increasingly nuanced links between linguistic, conceptual, and perceptual units (Balaban & Waxman, 1997; Booth & Waxman, 2003; Fulkerson & Haaf, 1998, 2003, 2006; Gopnik & Nazzi, 2003; Graham, Baker, & Poulin-Dubois, 1998; Waxman & Braun, 2005; Waxman & Lidz, 2006; Waxman & Markow, 1995; Xu, 2002). The current results favor this latter interpretation. They accord well with the view that there is indeed something special about words in the first year of life,

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and they challenge seriously the claim that infants enter the process of word-learning as *tabulae rasae*, with no links between linguistic units (e.g., words) and conceptual units (e.g., object categories) to guide acquisition.

The current results represent a first step toward characterizing the relation between words and concepts in infants on the threshold of word-learning. They also open the door for further investigation. In particular, it will be crucial to examine infants' responses to a broader range of stimuli, both linguistic and non-linguistic. Evidence is mounting that infants actually coordinate several kinds of cues in the service of establishing word meaning (Hall & Waxman, 2004; Hollich, Hirsh-Pasek, & Golinkoff, 2000; Roberts, 1995). For example, even non-linguistic elements such as whistles and brief melodic bursts may be interpreted as 'names for things' when an experimenter makes it clear that her *intention* is to treat these stimuli as object names (Campbell & Namy, 2003; Fulkerson & Haaf, 2003; Hollich et al., 2000; Namy, 2001; Namy & Waxman, 1998; Woodward & Hoyne, 1999). Importantly, when strong interpersonal cues to naming are stripped away, non-linguistic stimuli have no such effect (Balaban & Waxman, 1997; Fulkerson & Haaf, 2003). However, these findings highlight the need to identify the relevant linguistic and non-linguistic cues brought to bear in the service of word-learning and to ascertain *how* infants recruit these cues in mapping words to meaning.

It will also be important to detail with greater precision which properties of linguistic stimuli provide them their conceptual force in the first year of life. We suspect that the influence initially reflects infants' sensitivity to infant-directed speech and to content words and that a sensitivity to more specific syntactic and semantic properties follows. From birth, infants are exquisitely attuned to human speech (Molfese, Freeman, & Palermo, 1975; Vouloumanos & Werker, 2004), and are especially attracted to the heightened pitch and exaggerated intonational contours of infant-directed speech (Cooper & Aslin, 1990; Fernald, 1992; Fernald et al., 1989). During the first six months, infant-directed speech primarily engages and modulates attention (Fernald, 1992; Kaplan, Goldstein, Huckeby, Owren, & Cooper, 1995). However, in the second six months, "words begin to emerge from the melody" (Fernald, 1992, p. 403) as infants start to parse content words from the ongoing speech stream and to show a preference for content words over function words (Mandel-Emer, 1997; Shi & Werker, 2003). By their second year, infants show even greater differentiation as they begin to distinguish between more specific grammatical forms (such as nouns and adjectives) and link them to different kinds of meaning (object categories and object properties, respectively) (Booth & Waxman, 2003; Waxman & Booth, 2001, 2003).

In sum, the current results reveal that a link between linguistic and conceptual units is available early enough to guide infants' first steps in word-learning. To characterize this link with greater precision, it will be critical to examine infants' sensitivity to various properties of the speech signal, including acoustic, syntactic, semantic, and pragmatic properties of words, as they unfold over development and as they relate to meaning.

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References

Balaban, M. T., & Waxman, S. R. (1997). Do words facilitate object categorization in 9-month-old infants? *Journal of Experimental Child Psychology, 64*, 3–26.

Booth, A. E., & Waxman, S. R. (2002). Object names and object functions serve as cues to categories for infants. *Developmental Psychology, 38*, 948–957.

Booth, A. E., & Waxman, S. R. (2003). Mapping words to the world in infancy: infants' expectations for count nouns and adjectives. *Journal of Cognition and Development, 4*, 357–381.

Campbell, A. L., & Namy, L. L. (2003). The role of social-referential context in verbal and nonverbal symbol learning. *Child Development, 74*, 549–563.

Cheour, M., Ceponiene, R., Lehtokoski, A., Luuk, A., Allik, J., Alho, K., et al. (1998). Development of language-specific phoneme representations in the infant brain. *Nature Neuroscience, 1*, 351–353.

Cooper, R. P., & Aslin, R. N. (1990). Preference for infant-directed speech in the first month after birth. *Child Development, 61*, 1584–1595.

Fennell, C. T. & Waxman, S. R. (2006, June). Infants of 14 months use phonetic detail in novel words placed in naming phrases. In C. T. Fennell (Chair), *How the speech signal affects word learning, and vice-versa.* Symposium conducted at the International Conference on Infant Studies, Kyoto, Japan.

Fernald, A. (1992). Human maternal vocalizations to infants as biologically relevant signals: an evolutionary perspective. In J. H. Barkow, L. Cosmides, & J. Tooby (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 391–428). New York: Oxford University Press.

Fernald, A., Taeschner, T., Dun, J., Papousek, M., de Boysson-Bardies, B., & Fukui, I. (1989). A cross-language study of prosodic modifications in mothers' and fathers' speech to preverbal infants. *Journal of Child Language, 16*, 477–501.

Fulkerson, A. L., & Haaf, R. A. (1998). New words for new things: The relationship between novel labels and 12-month-olds' categorization of novel objects. Poster session presented at the International Conference on Infant Studies, Atlanta, GA.

Fulkerson, A. L., & Haaf, R. A. (2003). The influence of labels, non-labeling sounds, and source of auditory input on 9- and 15-month-olds' object categorization. *Infancy, 4*, 349–369.

Fulkerson, A. L., & Haaf, R. A. (2006). Does object naming aid 12-month-olds' formation of novel object categories? *First Language, 26*, 347–361.

Gogate, L. J., & Bahrick, L. E. (2001). Intersensory redundancy and 7-month-old infants' memory for arbitrary syllable-object relations. *Infancy, 2*, 219–231.

Gogate, L. J., Bahrick, L. E., & Watson, J. D. (2000). A study of multimodal motherese: the role of temporal synchrony between verbal labels and gestures. *Child Development, 71*, 878–894.

Gomez, R. (2002). Variability and detection of invariant structure. *Psychological Science, 13*, 431–436.

Gopnik, A., & Nazzi, T. (2003). Words, kinds, and causal powers: A theory perspective on early naming and categorization. In D. H. Rakison & L. M. Oakes (Eds.), *Early category and concept development: Making sense of the blooming, buzzing confusion* (pp. 303–329). New York: Oxford University Press.

Graham, S. A., Baker, R. K., & Poulin-Dubois, D. (1998). Infants' expectations about object label reference. *Canadian Journal of Experimental Psychology, 52*, 103–113.

Please cite this article in press as: Fulkerson, A. L., & Waxman, S. R., Words (but not Tones) facilitate object . . . , *Cognition* (2006), doi:10.1016/j.cognition.2006.09.005

Graham, S. A., Kilbreath, C. S., & Welder, A. N. (2004). 13-Month-olds rely on shared labels and shape similarity for inductive inferences. *Child Development, 75*, 409–427.

Johnson, E. K., & Jusczyk, P. W. (2001). Word segmentation by 8-month-olds: when speech cues count more than statistics. *Journal of Memory and Language, 44*, 548–567.

Hall, D. G., & Waxman, S. R. (Eds.). (2004). *Weaving a lexicon*. Cambridge: MIT Press.

Hollich, G. J., Hirsh-Pasek, K., & Golinkoff, R. M. (2000). Breaking the language barrier: an emergentist coalition model for the origins of word learning. *Monographs of the Society for Research in Child Development, 65* (3, Serial No. 262).

Houston, D. M., Jusczyk, P. W., Kuijpers, C., Coolen, R., & Cutler, A. (2000). Cross-language word segmentation by 9-month-olds. *Psychonomic Bulletin and Review, 7*, 504–509.

Kaplan, P. S., Goldstein, M. H., Huckeby, E. R., Owren, M. J., & Cooper, R. P. (1995). Dishabituation of visual attention by infant- versus adult-directed speech: effects of frequency modulation and spectral composition. *Infant Behavior and Development, 18*, 209–223.

Mandel-Emer, D. R. (1997). Names as early lexical candidates: Helpful in language processing? (Ph.D. Dissertation, State University of New York at Buffalo). *Dissertation Abstracts International*, 57, 5947.

Molfese, D. L., Freeman, R. B., & Palermo, D. S. (1975). The ontogeny of brain lateralization for speech and nonspeech stimuli. *Brain and Language, 2*, 356–368.

Namy, L. L. (2001). What's in a name when it isn't a word? 17-month-olds' mapping of nonverbal symbols to object categories. *Infancy, 2*, 73–86.

Namy, L. L., & Waxman, S. R. (1998). Words and gestures: infants' interpretations of different forms of symbolic reference. *Child Development, 69*, 295–308.

Oller, D. K. (1980). The emergence of the sounds of speech in infancy. In G. H. Yeni-Komshian, J. F. Kavanagh, & C. A. Ferguson (Eds.), *Child phonology* (Vol. 1, pp. 93–112). New York: Academic Press.

Oller, D. K., & Lynch, M. P. (1992). Infant vocalizations and innovations in infraphonology: toward a broader theory of development and disorders. In C. A. Ferguson, L. Menn, & C. Stoel-Gammon (Eds.), *Phonological development: Models, research, implications* (pp. 509–538). Timonium, MD: York Press.

Roberts, K. (1995). Categorical responding in 15-month-olds: influence of the noun-category bias and the covariation between visual fixation and auditory input. *Cognitive Development, 10*, 21–41.

Roberts, K. (1997). Linguistic and nonlinguistic factors influencing infant categorization: studies of the relationship between cognition and language. In C. Rovee-Collier & L. P. Lipsitt (Eds.), *Advances in infancy research* (Vol. 11, pp. 45–108). Norwood, NJ: Ablex.

Roberts, K., & Jacob, M. (1991). Linguistic versus attentional influences on nonlinguistic categorization in 15-month-old infants. *Cognitive Development, 6*, 355–375.

Robinson, C. W., & Sloutsky, V. M. (2006). Categorization in infancy: When sounds and labels hinder category learning. In *Proceedings of the XXVIII Annual Conference of the Cognitive Science Society* (pp. 2038–2041). Mahwah, NJ: Erlbaum.

Shi, R., & Werker, J. F. (2003). The basis of preference for lexical words in 6-month-old infants. *Developmental Science, 6*, 484–488.

Smith, L. B. (1999). Children's noun learning: How general learning processes make specialized learning mechanisms. In B. MacWhinney (Ed.), *The emergence of language* (pp. 277–303). Mahwah, NJ: Erlbaum.

Smith, L. B., Colunga, E., & Yoshida, H. (2003). Making an ontology: Cross-linguistic evidence. In D. H. Rakison & L. M. Oakes (Eds.), *Early category and concept development: Making sense of the blooming, buzzing confusion* (pp. 275–302). New York: Oxford University Press.

Tincoff, R., & Jusczyk, P. (1999). Some beginnings of word comprehension in 6-month-olds. *Psychological Science, 10*, 172–175.

Vouloumanos, A., & Werker, J. F. (2004). Tuned to the signal: the privileged status of speech for young infants. *Developmental Science, 7*, 270–276.

Waxman, S. R. (1998). Linking object categorization and naming: early expectations and the shaping role of language. *The Psychology of Learning and Motivation, 38*, 249–291.

Waxman, S. R., & Booth, A. E. (2001). Seeing pink elephants: fourteen-month-olds' interpretations of novel nouns and adjectives. *Cognitive Psychology, 43*, 217–242.

Waxman, S. R., & Booth, A. E. (2003). The origins and evolution of links between word learning and conceptual organization: new evidence from 11-month-olds. *Developmental Science, 6*, 128–135.

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Waxman, S. R., & Braun, I. E. (2005). Consistent (but not variable) names as invitations to form object categories: new evidence from 12-month-old infants. *Cognition, 95*, B59–B68.

Waxman, S. R., & Lidz, J. (2006). Early word learning. In D. Kuhn & R. Siegler (Eds.), *Handbook of Child Psychology* (Vol. 2, 6th ed., pp. 299–335). Hoboken, NJ: Wiley.

Waxman, S. R., & Markow, D. B. (1995). Words as invitations to form categories: evidence from 12- to 13-month-old infants. *Cognitive Psychology, 29*, 257–302.

Welder, A. N., & Graham, S. A. (2001). The influence of shape similarity and shared labels on infants' inductive inferences about nonobvious object properties. *Child Development, 72*, 1653–1673.

Welder, A. N., & Graham, S. A. (2006). Infants' categorization of novel objects with more or less obvious features. *Cognitive Psychology, 52*, 57–91.

Werker, J. F., Fennell, C. T., Corcoran, K. M., & Stager, C. L. (2002). Infants' ability to learn phonetically similar words: effects of age and vocabulary size. *Infancy, 3*, 1–30.

Werker, J. F., & Tees, R. C. (1984). Cross-language speech perception: Initial capabilities and developmental change. *Infant Behavior and Development, 7*, 49–63.

Woodward, A. L., & Hoyne, K. L. (1999). Infants' learning about words and sounds in relation to objects. *Child Development, 70*, 65–77.

Werker, J. F., & Lalonde, C. E. (1988). Cross-language speech perception: Initial capabilities and developmental change. *Developmental Psychology, 24*, 672–683.

Xu, F. (1999). Object individuation and object identity in infancy. The role of spatiotemporal information, object property information, and language. *Acta Psychologica, 102*, 113–136.

Xu, F. (2002). The role of language in acquiring object kind concepts in infancy. *Cognition, 85*, 223–250.

Please cite this article in press as: Fulkerson, A. L., & Waxman, S. R., Words (but not Tones) facilitate object . . . , *Cognition* (2006), doi:10.1016/j.cognition.2006.09.005