With Referential Cues, Infants Successfully Use Phonetic Detail in Word Learning

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1. Introduction

The relation between speech perception and word learning in infancy has become a focus for research in early language acquisition (e.g., Fikkert, 2005; Jusczyk & Aslin, 1995; Swingley & Aslin, 2002; Werker, Fennell, Corcoran & Stager, 2002). Considerable attention has been paid to a surprising discrepancy. Although infants' performance in speech discrimination tasks reveals their sensitivity to phonetic detail in their native language (e.g., Werker & Tees, 1984), they apparently have difficulty recruiting detailed phonetic information in the task of word learning. Indeed, there are several reports of infants and toddlers having difficulty distinguishing between similar-sounding words in their initial lexicon (e.g., Barton, 1980; Brown & Matthews, 1997; Stager & Werker, 1997). The aim of this paper is to demonstrate that this discrepancy is not robust. We provide evidence that infants do indeed recruit their refined phonetic perception skills in their early word learning. When the word learning situation is facilitated by clarifying the referential status of the novel word, infants successfully attend to relevant sound distinctions. These findings support the cognitive load hypothesis (Werker & Fennell, 2004), a theoretical position that argues for continuity in the sound representations used in infant speech perception and early word learning.

1.1. An apparent paradox: Speech perception and early word learning

Infants' ability to discriminate the sound units of their native language is well-established in the literature, both in behavioural (Werker & Tees, 1984) and neuroimaging (Cheour, Alho & Sainio, 1997) work. Given the wealth of evidence for early phonetic discrimination, the finding that early word learners were apparently unable to distinguish similar-sounding words, or minimal pairs, was paradoxical. Multiple studies have demonstrated that infants of 14 months fail to distinguish object labels that differ in a single sound, even though infants this age discriminate these sounds in speech perception tasks that involve no object associations (e.g., Pater, Stager & Werker, 2004; Stager & Werker, 1997). Yet, word learners' minimal pair confusion does not persist across the entire infancy period. Infants of 17 and 20 months are able to distinguish similar-sounding novel words (Werker, et al., 2002). Nor does it extend across all testing contexts at 14 months. Fennell and Werker (2003) demonstrated that infants this age can distinguish similar-sounding, well-known words, like "ball" and "doll", in the task (see also Swingley & Aslin, 2002). Infants of 14 months also succeed in using phonetic detail in a novel word when they are familiarized to the referent (i.e., the object) prior to the task (Werker & Fennell, in press). An explanation is needed for why infants' failure to use their refined phonetic perception skills is specifically restricted to the situation where novice word learners are dealing with novel words and objects.

Werker and her colleagues have argued that infants do have the underlying ability to use phonetic detail in words, but that the ability is initially tenuous and easily overwhelmed by task demands (e.g., Fennell & Werker, 2003; Stager & Werker, 1997; Werker & Fennell, 2004). In a word learning task where the infant is required to establish object-label linkages, like the one used by Stager and Werker (1997), the infant must track the properties of both the spoken label and the visual object, and simultaneously establish the link between the object and label. Werker and Fennell argued that the establishment and maintenance of the word-referent linking[1] is a complex task for novice word learners and therefore taxes their cognitive resources. However, older word learners, with their greater expertise, would not face the same demands as the younger infants. Older infants' greater word learning experience would allow them to rapidly link the object and word in the task, thus reducing the demands of the learning situation. Further, if a word is already known, the infant faces far fewer demands, as there is no need to learn the link between the label and the object category. Finally, in a speech perception task, which involves no referent at all, even young infants succeed because no word-referent links are required. Under this explanation, there is continuity between infants' refined speech perception skills and early word learning. Phonetic information is incorporated into the representations of early words, but task demands may mask its use.

However, researchers in child phonology have offered a competing interpretation, postulating that detailed phonetic information is not instantiated in the lexical representations of very young word learners. Some phonologists have argued that the difficulties seen in early word learning with respect to phonetic/phonological information support the position that novice word learners initially have incomplete phonological/lexical representations (e.g., Brown & Matthews, 1997; Charles-Luce & Luce, 1995; Metsala & Walley, 1998). These theorists argue that phonological and/or lexical representations only become detailed over time, whether by the addition of new words to the vocabulary, or through a set step-wise progression of phoneme acquisition. There is no direct continuity between the refinement of phonetic sensitivities in the first year of life and early word learning in the second year. The important point here is that, unlike the resource limitation hypothesis, any reduction in task

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1. Although the focus in the research has been on object words, other word-referent links should be as, if not more, difficult for novice word learners (e.g., properties, actions, abstract ideas, etc.).

demands should have absolutely no effect on infants' use of sound details in words, as the underlying representations are incomplete.

1.2. The poverty of referential stimulus: Testing the explanations

Fennell and Waxman (in prep; see also Fennell, 2006) decided to test these competing hypotheses by enriching the infant's word learning situation. They noted that, in previous work testing use of phonetic detail in novel words, researchers had presented infants with auditory labels in isolation (e.g., "Din! Din!") when pairing the labels to objects. Although this manipulation efficiently controlled the speech stimuli and made the design comparable to speech perception experiments, it may have had adverse consequences for word learning. Fennell and Waxman proposed that isolated labels are problematic: they do not provide unambiguous evidence regarding the referential status of the novel words. Although the experimenters intended for the labels to be interpreted by the infants as object names, the labels may have been interpreted as exclamations (i.e., Wow!) or another part of speech (verb, adjective, etc.). The lack of direct referential information for the object label (such as syntax indicating the novel word is a noun or pragmatic information indicating that it is meant to name an object) presents novice word learners with a referential hurdle, and this may have interfered with the infants' ability to use phonetic information. This suggestion is in line with the cognitive load hypothesis.

One way to get around this hurdle is to present the novel words within familiar naming phrases, such as "Look at the ____" or "That's the ____". The syntactic information present in a naming phrase, such as the use of determiners, directly indicates that the novel word is a noun, and thus a candidate name for the novel object. Further, the use of familiar naming phrases (that infants have no doubt encountered in word learning situations outside the laboratory) should ease the laboratory word learning task. Indeed, there is evidence documenting the facilitative effect of naming phrases. Using an object categorization task, Namy and Waxman (2000) established that 17-month-old infants map novel words to object categories more successfully when those novel words were presented in the context of naming phrases than when presented in isolation. Using the looking-while-listening procedure, Fernald and Hurtado (2006) found that 18-month-old infants process familiar words quicker in a naming phrase than in isolation. Although these studies involved slightly older infants and different procedures, Fennell and Waxman (in prep) proposed that these facilitative effects would extend to 14-month-old infants in the Switch procedure, the object-label associative task used in previous research.

To make their study directly comparable to past research, Fennell and Waxman (in prep) used the exact same design parameters and target contrast as Stager and Werker (1997) and Werker, et al. (2002). The only change to the procedure was the placement of the target words in naming phrases. A female speaker produced seven naming phrases. Each naming phrase was repeated using the nonsense words "bin", "din", or "neem". The first two similar-sounding words were the test words and the third, which was very dissimilar-sounding to the other two, functioned as the pre- and post-test word. The researchers wanted to ensure that no subtle sound differences in the naming phrases themselves between word conditions would allow the infants to succeed in the task (e.g., raised pitch in the "bin" naming phrases compared to the "din" phrase). Therefore, they spliced the naming phrases from the neem stimuli before the determiner (e.g., "Look at | the neem."), copied the splices (e.g., "Look at"), and spliced the endings from the bin and din lists on to the copies. This resulted in sentences where the introductory parts of the naming phrases were identical, as indicated in italics: "*Look at* the neem!"; "*Look at* the bin!"; and "*Look at* the din!". The decision was made to splice the sentences before the determiner in order to maintain the natural coarticulatory cues between the determiner and the target word.

Fennell and Waxman (in prep) tested infants in the two versions of the Switch task. In the first version, infants are presented with one novel object-label combination during habituation and are tested on a change in the auditory label. In the second, more challenging, version, infants are taught two object-label combinations during habituation whose labels are minimally different, and are then tested by presenting one of the objects from habituation and pairing it with the other object's name. When the object labels were presented in naming phrases, they found that infants of 14 months succeeded noticing the minimal change in object label in the one object-label version of the Switch task, in contrast to their failures in this task when words were presented in isolation (e.g., Pater, Stager & Werker, 2004). This demonstrated that, when the referential status of the word was clarified, novice word learners successfully recruited their phonetic sensitivities in word learning, presenting a challenge to theories that postulate incomplete phonological/lexical representations in early word learning. Fennell and Waxman argued that reduction of cognitive demands afforded the infants by the use of naming phrases allowed those infants to use phonetic detail in novel words, demonstrating continuity between infant speech perception and early word learning. The infants could more readily establish the link between the novel word and its referent than when novel words were presented in isolation. In line with the resource limitation hypothesis, the more taxing task of learning a minimal pair simultaneously, the two word-object combination task, presented too much of a challenge for the infants and they did not notice the pairing violation. The facilitative effect of naming phrases was not enough to get over that particular learning hurdle.

1.3. Referential status or coarticulatory information?

Fennell and Waxman (in prep; Fennell, 2006) argued that the use of naming phrases helped to cement the link between object and label, which reduced the demands placed on the infant and allowed for use of phonetic detail. There is, however, another possibility. It may not have been the referential clarity that led to infant success in the task. Infants could potentially use perceptual information present in the naming phrase task that was absent the isolated word task: the coarticulatory effects between the determiner and the target words. In running speech, coarticulation effects occur as we move from one articulatory gesture to another, and listeners are perceptually sensitive to these effects on individual sounds (e.g, Martin & Bunnell, 1982). For this very reason, Fennell and Waxman had preserved the coarticulation between the determiner “the” and the target words “bin” and “din”. Unnatural sounding stimuli may have disrupted the task. However, these extra cues may have been the facilitative effect that led to infant success, not referential clarity.

Previous work indicated that there were specific learning situations involving no additional speech information where infants of 14 months exploit referential information to succeed in distinguishing similar-sounding words. In these studies, novice word learners noticed sound changes in *isolated* words. For example, infants of 14 months distinguished minimally different well-known words in isolation (Fennell & Werker, 2003). They also notice auditory changes in an object’s label when they have been familiarized with the target object (without a label) prior to the word learning task (Werker & Fennell, in press). In the first case, the referential status of the word is evident, as it is already known, and the referential link in the second case is aided by the infants’ drive to search for a name for a known object (e.g., Macnamara, 1982). But, would infants of 14 months be able to succeed in the case where both the object and the label were novel? To answer this question, we needed a design that established the referential status of the novel words without adding any extra perceptual cues.

Turning to the word learning literature, we were inspired by a referential training design found in Namy and Waxman (2000). The researchers had wished to know if there were any contexts in which an isolated word would be transparently referential, rather than being interpreted as a non-referential word such as an exclamation. To accomplish this, they included a training phase prior to the main learning phase of the experiment. In this training phase, infants were shown familiar objects (e.g., a toy car) while hearing the object labels in isolation (“Car! Car!”). The experimenter then showed infants a novel object and labelled it with an isolated word (e.g., “Blicket!”). Infants now succeeded in extending the novel label to new members of the object category, unlike their failure to correctly extend the label when no training phase was involved in the isolated word condition. The training phase had made the isolated novel word clearly referential. We adapted this idea to the Switch task. We hypothesized that the referential clarity provided by a training phase would allow for a reduction in cognitive demands and allow infants to succeed in using phonetic detail in isolated novel words, even in the absence of any additional auditory cues such as coarticulation.

2. Experiment

In this Experiment, we used the simplest variant of the Switch task. Infants were habituated to one word-object pairing and then tested on a change, or ‘switch’, in the auditory label. The habituation and test phase methodology and stimuli were nearly identical to Fennell and Waxman (in prep; Fennell, 2006), with the only change being a reduction in trial length from 20 to 14 seconds to accommodate the addition of a training phase prior to the habituation phase. In this training phase, infants received three word-object pairings familiar to many infants this age (car, cat, and shoe). The objects’ labels were presented in isolation (“Car!”, “Kitty!”, “Shoe!”). This was done to familiarize infants with a context in which an isolated word could refer to a shown object. We predicted that infants this age would successfully attend to phonetic detail and establish precise word-object mappings.

2.2 Methods

2.2.1. Participants

Sixteen infants (mean = 14.7 months, range = 13.5 – 15.5 months) from the greater Chicago area participated. The criteria for inclusion in the study were that the infants had to be primarily exposed primarily to English (at least 80% exposure), have no apparent or reported health problems, and needed to comprehend at least one of the three training words (car, kitty, or shoe), as measured by a vocabulary questionnaire - the MacArthur-Bates Communicative Development Inventory, or CDI (Fenson, et al., 1993). Three infants completed the study, but did not know any of the training words and were therefore excluded from the analyses. An additional seven infants were excluded due to: restlessness (3), technical errors (2), becoming upset (1), and parental interference (1).

2.2.2. Stimuli

The audio stimuli consisted of three potentially familiar words and three novel CVC words, produced by an English-speaking female in infant-directed speech (IDS) and recorded in a soundproof booth. The three potentially familiar words were “car”, “kitty”, and “shoe”. Two of the novel words formed a minimal pair that differed only in the place of articulation of the initial consonant: “bin” and “din”. The third novel word, “neem”, was highly dissimilar from the other words and was used during the post-test trials. Each trial included seven instances of the target word in varying intonations. The intonational pattern was identical across all trials.

The three potentially familiar words were paired with prototypical images of their referents (see Figure 1, a through c). One novel object was used for the habituation and test trials (see Figure 1d). The object was fashioned out of red, yellow, and blue clay. A store-bought, multicoloured toy water wheel (“spinner”) was used for the post-test (see Figure 1e). The training and habituation/test object images appeared on a black background and were animated using the program Final Cut Pro to move back and forth across the screen at a slow and constant velocity. The “spinner” was filmed on a black background with the base remaining stationary while the wheel was moved around in a clockwise motion and was transferred on to digital format.

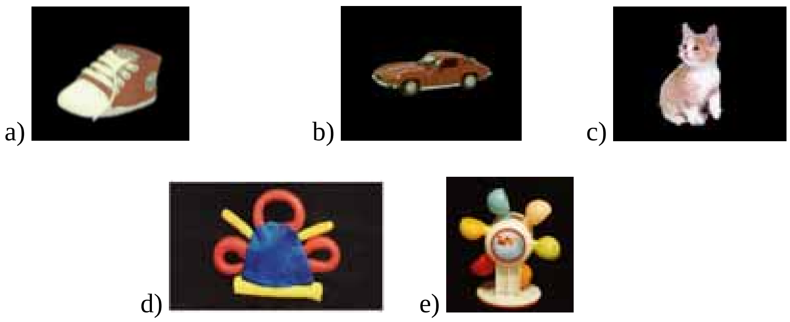

Figure 1: Visual stimuli

2.2.3. Apparatus

The experiment took place in a 3.12 m by 3.89 m quiet room, which was dimly lit by a shaded 60W lamp situated 60 cm to the left and slightly behind the infant. The infant sat on the parent's lap facing a projection screen that was approximately 1.93 m away. The visual stimuli were projected onto the screen using an InFocus projector. The audio stimuli were delivered at 65 dB, +/- 5 dB, over two Altec Lansing speakers, located directly below the screen. The monitor was surrounded by black cloth, which stretched the width and height of the room. The infants were recorded using a Sony 8mm digital video camera connected directly to a Macintosh G7 laptop computer. The image from the camera was captured using the iMovie program. The lens of the video camera peeked out of a hole in the black cloth located 1.27 cm below the screen. As a masking control during testing, the parent wore Peltor headphones over which female vocal music was played from an Audiophase portable CD player.

The experiment was controlled by a version of the Habit program and run on a Macintosh G7 laptop. The visual and audio stimuli, played from digitized files on the computer, were synchronized and sent to the monitor and speaker. The experimenter monitored infants' looking times via a closed circuit system from behind the projection screen and black cloth curtains. A designated key was pressed on the computer keyboard during infant looks, which the Habit program recorded. The video record was used for subsequent reliability coding.

2.2.4 Procedure

After the parent(s) arrived at the laboratory, the experimenter explained the procedure and gathered a signed consent form. Parent(s) then completed the CDI. The infant and one parent were then taken to the testing room and positioned for the experiment. The experimenter went to the observation area and began the procedure. Infants were assigned to one of four possible orders. These insured that order of test trial (same before switch/switch before same) and the novel word presented during habituation ("bin" or "din") were counterbalanced.

Each fixed trial was 14 seconds long and began when the infant fixated on a dynamic stimulus (an oval shape that changed size and colour). The first three trials constituted the training phase. Infants heard a potentially familiar audio stimulus presented in isolation and paired with the appropriate object. The order of these three trials was counterbalanced across infants. After completing the training phase, the habituation phase began. Infants were habituated to one object-label pair (e.g., the clay object and "bin" presented in isolation). Looking time was calculated on-line; when the average looking time across a two-trial block decreased to 65%, the habituation phase ended. Infants participated in a minimum of four and a maximum of 24 habituation trials.

Following habituation, the test phase began. One test trial was a 'same' trial in which the pairing presented in the habituation phase was presented again (e.g., clay object – "bin"). The other trial, the 'switch' trial, presented the same visual object, paired with a (minimally) different word (e.g., "din"). If infants had learned the pairing, then they should detect the 'switch' and look longer on 'switch' than on 'same' trials. Finally, in a post-test trial, infants were presented with the spinner-"neem" pairing. If infants were still involved in the task, their looking time should recover to this radically different pairing.

2.2.5 Coding

For key trials (i.e., the two test trials and the posttest), infants' looking times to the object were analyzed in a frame-by-frame (1 frame = 33.33 msec) analysis.

2.3 Results

A paired t-test confirmed that infants recovered from habituation. There was a significant difference between the last habituation block (M = 6.15 s) and posttest (M = 12.43 s): [$t(1, 15) = 10.72$, $p < .001$]. A 2 (sex: female vs. male) X 2 (habituation block: first two habituation trials vs. last two habituation trials) mixed ANOVA produced a significant main effect for habituation block, with no main effect for gender [$F(1, 14) = 96.32$, $p < .001$; First Block = 10.96 s, Last Block = 6.15 s]. Thus, as expected, there was a significant drop in looking time across the habituation phase.

The main set of analyses addressed infants' performance at test. A 2 (sex: female vs. male) X 2 (test trials: same vs. switch) mixed ANOVA revealed a significant main effect for test trials [$F(1, 14) = 7.94$, $p = .01$]. As predicted, infants looked reliably longer on switch (M = 8.67 s) than on same (M = 6.76 s) trials. (See Figure 2.) There were no other main effects or interactions. Thus, when 14-month-old infants are trained that novel words presented in isolation can refer to objects, they use fine phonetic detail in establishing word-object mappings.

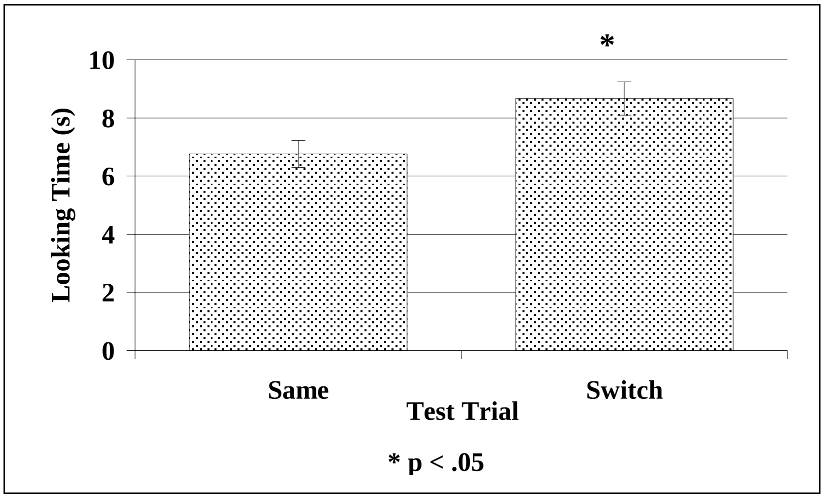

Figure 2: Infants' looking times (s) to the test trials

3. General Discussion

The results provide further evidence that clarifying the referential status of a novel word aids novice word learners' use of phonetic detail in that novel word. Even in the absence of any additional perceptual cues, such as coarticulation, the infants noticed an auditory change in the object label after being trained that isolated words can refer to objects. Studies that have used the same habituation and testing procedure, but lack a referential training phase, have repeatedly found that infants this age fail to notice sound changes in novel words (Fennell, 2004; Pater, Stager & Werker, 2004; Stager & Werker, 1997). This finding supports the position that novice word learners possess the ability to perceive, access, and use the detailed phonetic information refined during the first year in early word learning – but only when the situation is clearly one of referential word learning. The results pose a significant challenge to theoretical positions that hold that phonemes, or broader lexical representations, are initially underspecified.

One possible issue concerning the results of the study relates to the vocabulary criteria stipulated for inclusion in the final analyses. We only included those infants who comprehended at least one of the training words. This was done for obvious reasons: the training phase would only work if the infants knew that the isolated words served as labels for the objects. However, those infants who did not know any of the training words had lower comprehension vocabulary sizes (N = 3; M = 45 words) than those infants who knew one or more of the words (N = 16; M = 161 words). Some previous research has demonstrated a positive correlation at 14 months between vocabulary size and ability to notice phonetic detail in object labels (Werker et al., 2002; but see Swingley & Aslin, 2002 for an opposing point of view). Could it be that the success of the infants in our task relates not to the training phase, but to the fact that infants with small vocabularies were inadvertently excluded from the results?

There are three pieces of evidence that indicate that the above alternative explanation does not hold. The first evidence comes directly from the infants who participated in our study. Based on the CDI's percentile ranking scores for comprehension vocabulary (Fenson et al., 1993), two of the three infants excluded for not knowing any target words could be directly matched to infants included in the results (i.e., infants who knew one or more training words). In the first pairing, the included infant had a percentile score of 20, indicating that 80 percent of children this age had larger vocabularies, and the excluded infant had a percentile score of 15. The included infant looked 5.7 s longer to the 'switch' trial than to the 'same' trial, whereas the excluded infant had the reverse pattern, looking 5.5 s longer to the 'same' trial than to the 'switch'. The same pattern of results held for the second pairing (Included infant: comprehension percentile = 5, looked 1 s longer to 'switch' over 'same'; Excluded infant: comprehension percentile = 10, looked 1.6 s longer to 'same' over 'switch'). This pattern indicates that the key factor is whether the infants knew one or more of the training words, not their vocabulary size.

The second piece of evidence is that, with all infants included in the analyses (i.e., those who knew training words and those who did not), comprehension vocabulary size did not significantly correlate with ability to notice the change in label, as measured by greater looking time to the 'switch' than to the 'same' trial [$r(17) = .34$, $p = .16$]. However, the number of training words known (0 to 3) significantly correlated with performance in the task [$r(17) = .50$, $p = .03$]. Once again, these data demonstrate that it is not total comprehension vocabulary size that impacted infants' performance, but their specific knowledge of the training words - knowledge crucial to understanding that isolated words could refer to the objects.

The final piece of evidence comes from previous research. Fennell (2004) ran a study similar to one outlined in this paper, but with no training phase included. The 14-month-old infants in that study failed to notice an auditory change in object label, yet they had similar-sized comprehension vocabularies (M = 179 words) to the infants included in our study (M = 161 words). This comparison across studies reveals two things: 1) it does not appear that the infants in our study had abnormally large vocabulary sizes, which could have accounted for their success; and 2) the inclusion of a training phase that increases referential clarity aids infants with similar-sized vocabularies to infants in past research who failed in the task.

One final point of consideration relates to our supposition that it was the specific nature of the training phase that allowed infants to succeed in the task.

Specifically, we argue that the referential nature of the training phase itself allowed the infant to clearly comprehend that they were facing a word learning task in the habituation phase. We are currently conducting a study to directly test this hypothesis. We are replicating the study outlined in this paper, with one major change. In the training phase of the current study, the objects (car, cat, and shoe) are not given their appropriate labels. Instead, the 14-month-old infants are hearing exclamations paired with the objects (“Wow!”, “Oooh!”, “Whee!”). This modification will allow us to test if it is the referential nature of the training phase that allowed for the reduction in cognitive demands, or whether the addition of any pre-habituation phase somehow influences infants’ performance in the task.

4. Conclusions

When provided with sufficient referential clarity, 14-month-old infants are able to use fine phonetic detail in mapping novel words to novel objects. Novice word learners can hold on to and use phonetic detail in novel words when it is unambiguous that the novel word is referential. It is only in the context of a referentially difficult task that the novice word learner is unable to demonstrate her underlying ability to use detail. This demonstrates that there is continuity between the phonetic representations refined over the first year and those recruited in early word-learning.

References

Barton, David (1980). Phonemic perception in children. In G. H. Yeni-Komshian, J. F. Kavanagh & C. A. Ferguson (Eds.), Child Phonology: Volume 2 – Perception. New York: Academic Press.

Brown, Cynthia & Matthews, John (1997). The role of feature geometry in the development of phonemic contrasts. In S. J. Hannahs & M. Young-Scholten (Eds.), Focus on Phonological Acquisition (pp. 67-112). Amsterdam: John Benjamins.

Charles-Luce, Jan & Luce, Paul A. (1995). An examination of similarity neighbourhoods in young children’s receptive vocabularies. Journal of Child Language, 22, 727-735.

Cheour, M., Alho, K., & Sainio, K. (1997). The mismatch negativity to changes in speech sounds at the age of three months. Developmental Neuropsychology, 13(2), 167-174.

Fennell, Christopher T. (2004) Infant attention to phonetic detail in word forms: Knowledge and familiarity effects. Unpublished doctoral dissertation, University of British Columbia, Vancouver.

Fennell, Christopher T. (2006). Infants of 14 Months use phonetic detail in novel words embedded in naming phrases. Proceedings of the 30th Annual Boston University Conference on Language Development, 178-189.

Fennell, Christopher T. & Waxman, Sandra R. (in prep). Infants of 14 months use phonetic detail in novel words embedded in naming phrases.

Fennell, Christopher T. & Werker, Janet F. (2003). Early word learners’ ability to access phonetic detail in well-known words. Language & Speech, 46(2), 245-264.

Fenson, L., Dale, P.S., Reznick, J.S., Thal, D., Bates, E., Hartung, J.P., Pethick, S., & Reilly, J.S. (1993). The MacArthur Communicative Development Inventories: User's Guide and Technical Manual. Baltimore : Paul H. Brokes Publishing Co.

Fernald, Anne & Hurtado, Nereyda (2006). Names in frames: Infants interpret words in sentence frames faster than words in isolation. Developmental Science, 9(3), F33-F40.

Fikkert, Paula (2005). Getting sounds structures in mind. Acquisition bridging linguistics and psychology? In: A.E. Cutler (Eds.), Twenty-First Century Psycholinguistics: Four Cornerstones. Lawrence Erlbaum Associates. 43-56.

Jusczyk, Peter W. & Aslin, Richard N. (1995). Infants' detection of the sound patterns of words in fluent speech. Cognitive Psychology, 29(1), 1-23.

Macnamara, John (1982). Names for things: A study of Human Learning. Cambridge : MIT Press.

Martin, J., & Bunnell, H. Timothy (1982). Perception of coarticulation effects in vowel-stop syllables. Journal of Experimental Psychology: Human Perception and Performance, 8, 473–488.

Metsala, Jamie L. & Walley, Amanda C. (1998). Spoken vocabulary growth and the segmental restructuring of lexical representations: Precursors to phonemic awareness and early reading ability. In J. L. Metsala & L.C. Ehri (Eds.), Word Recognition in Beginning Literacy (p. 89-120). Mahwah, NJ : Lawrence Erlbaum Associates.

Namy, Laura L., & Waxman, Sandra R. (2000). Naming and exclaiming: Infants' sensitivity to naming contexts. Journal of Cognition and Development, 1(4), 405-428.

Pater, Joe, Stager, Christine L., & Werker, Janet F. (2004). The lexical acquisition of phonological contrasts. Language, 80(3), 361-379.

Stager, Christine L. & Werker, Janet F. (1997). Infants listen for more phonetic detail in speech perception than in word-learning tasks. Nature, 388, 381-382.

Swingley, Daniel & Aslin, Richard N. (2002). Lexical neighbourhoods and the word-form representations of 14-month-olds. Psychological Science, 13, 480-484.

Werker, Janet F., Cohen, Leslie B., Lloyd, Valerie L., Casasola, Marinella & Stager, Christine L. (1998). Acquisition of word-object associations by 14-month old infants. Developmental Psychology, 34, 1289-1309.

Werker, Janet F. & Fennell, Christopher T. (2004). Listening to sounds versus listening to words: Early steps in word learning. In D. G. Hall & S. Waxman (Eds.), Weaving a Lexicon. (pp. 79-109). Cambridge : MIT Press.

Werker, Janet F. & Fennell, Christopher T. (in press). Infant Speech Perception and Later Language Acquisition: Methodological Underpinnings. In J. Colombo (Ed.), Infant Pathways to Language: Methods, Models, and Research Directions.

Werker, Janet F., Fennell, Christopher T., Corcoran, Kathleen M. & Stager, Christine L. (2002). Infants' ability to learn phonetically similar words: Effects of age and vocabulary. Infancy, 3, 1-30.

Werker, Janet F. & Tees, Richard C. (1984). Cross-language speech perception: Evidence for perceptual reorganization during the first year of life. Infant Behavior and Development, 7, 49-63.