CHILD DEVELOPMENT

Child Development, July/August 2012, Volume 83, Number 4, Pages 1129–1136

12-Month-Olds' Phonotactic Knowledge Guides Their Word–Object Mappings

Heather MacKenzie, Suzanne Curtin, and Susan A. Graham
University of Calgary

This study examined whether 12-month-olds will accept words that differ phonologically and phonetically from their native language as object labels in an associative learning task. Sixty infants were presented with sets of English word–object (N = 30), Japanese word–object (N = 15), or Czech word–object (N = 15) pairings until they habituated. Infants associated CVCV English, CCVC English, and CVCV Japanese words, but not CCVC Czech words, with novel objects. These results demonstrate that by 12 months of age, infants are beginning to apply their language-specific knowledge to their acceptance of word forms. That is, they will not map words that violate the phonotactics of their native language to objects.

Infants approach language learning with relatively open systems that gradually become more specified over time (Waxman & Lidz, 2006). Here, we ask whether 12-month-old infants have acquired knowledge about what constitutes an appropriate phonological form for an object label. That is, we examine whether infants will accept words that differ phonologically and phonetically from their native language as object labels in an associative learning task.

During the 1st year of life, infants begin to hone in on the characteristics of speech found within their native language. This movement from a ''language-general'' to ''language-specific'' shift in the processing of linguistic stimuli has been clearly illustrated in the change in abilities that occurs as infants become specialized in processing their native language (e.g., Kuhl, Williams, Lacerda, Stevens, & Lindblom, 1992; Werker & Tees, 1984). Seminal research has demonstrated that 6- to 8-month-olds can discriminate between consonant contrasts that are used within their native language and in unfamiliar foreign languages. Around 10 months of age, however, infants only distinguish contrasts that occur in their native language (Werker & Tees, 1984). This pattern of experience-based winnowing has been found to occur earlier for the acquisition of vowels (Bosch & Sebastian-Galles, 2003; Kuhl et al., 1992). This shift from language-general to language-specific perception reflects a functional reorganization rather than a loss (Werker, 1995 as infants attend to language-specific properties of their native language, allowing them to effectively discovery word and phrase boundaries.

In addition to tuning into the ambient language's speech sound categories, infants must determine their language's legal speech sound co-occurrences. By 9 months of age, infants can discriminate between legal and illegal sound combinations (Jusczyk, Frederici, Wessels, Svenkerud, & Jusczyk, 1993). They also recognize more probable speech sound combinations and positions (Jusczyk, Luce, & Charles-Luce, 1994), and prefer listening to legal sound combinations in legal positions (Friederici & Wessels, 1993). This awareness of phonotactic probabilities by 9-month-olds extends to positions within and across word boundaries (Mattys, Jusczyk, Luce, & Morgan, 1999). Thus, by 9 months, infants have developed sensitivity to legal sound combinations and to positional constraints on sound combinations at word beginnings and endings for their native language.

Although the research described earlier provides compelling evidence that infants begin to narrow their sensitivity to linguistic properties that correspond to their native language by the end of their 1st year, it is unclear whether this knowledge is recruited when learning new words. Indeed, there is evidence that 14-month-olds do not use their

This research was supported by funding from SSHRC awarded to SC and SG, and funding from NSERC, the Canada Research Chairs program, and the Canada Foundation for Innovation awarded to SG. HM was supported by graduate funding from SSHRC. We thank the parents and infants who participated as well as Julie Sedivy, Kimiko Nakanishi, and Amy Nakashima for their assistance with this research.

Correspondence concerning this article should be addressed to Suzanne Curtin, Department of Psychology, University of Calgary, Calgary, AB T2N 1N4 Canada. Electronic mail may be sent to scurtin@ucalgary.ca.

 0009-3920/2012/8304-0003
DOI: 10.1111/j.1467-8624.2012.01764.x

native-language sound categories when engaged in a word–object associative learning task (Stager & Werker, 1997). Even at 15 months, infants only form mappings between novel words and objects with a subset of native-language vowel categories (Curtin, Fennell, & Escudero, 2009), and results from interactive object categorization tasks demonstrate that 20-month-olds confuse novel words that minimally differ in their vowel, while succeeding in distinguishing words that minimally differ in consonants (Nazzi, 2005; Nazzi & New, 2007). Further evidence that infants' knowledge about their native language is not necessarily recruited into word learning comes from studies demonstrating that young infants are flexible in the range of forms that they will accept as object labels when these forms are presented in an interactive naming task (e.g., Namy & Waxman, 1998; Woodward & Hoyne, 1999). For example, 12-month-olds will map nonverbal mouth noises (e.g., ''psst'') to objects using an interactive preferential looking paradigm (Hollich, Hirsh-Pasek, & Golinkoff, 2000). This general symbolic openness begins to narrow toward the end of the 2nd year when infants begin to accept only words as object names (e.g., Graham & Kilbreath, 2007; Namy & Waxman, 1998). Together, these findings suggest that while a great deal of language learning, including knowledge about native-language phonology, has taken place over the first 2 years, this information is not always accessible or used when learning new words.

In these experiments, we pursued the question of whether infants' sensitivity to the linguistic properties that correspond to their native language extends to the types of words infants are willing to accept as labels for objects. We ask what kinds of constraints on word forms, if any, do infants possess at the onset of their productive language? Specifically, we examine whether such constraints are limited solely by native-language phonotactics or whether the phonetic realizations of phonemes also impacts word learning. To this end, we compare 12-month-olds' acquisition of novel English word–object pairings to their acquisition of forms that violate native-language phonotactics (Czech) or forms that violate the low-level phonetic realization of phonemes (Japanese).

Experiment 1

We examined whether 12-month-olds accept words that differ phonologically and phonetically from their native language as object labels in an associative learning task. We contrasted different types of ''noun-like'' forms that vary in their phonological similarity to English content-type words. To directly compare infants' mappings of illegal CCVC words versus legal CCVC words, we used CCVC Czech words that contain sound combinations that are illegal in English (i.e., violate English phonotactics) and legal CCVC English words. To compare infants' mapping of phonologically legal sequences that differ phonetically from English, we presented novel phonologically legal CVCV English words and CVCV Japanese words. That is, we used Japanese words containing a high vowel (/i/), which devoices when not contiguous with a voiced sound (Comrie, 1990).

If infants are open in what they consider to be an appropriate label for an object, then they should learn the word–object pairings for all types of word forms. However, if infants have refined their preferences for object labels to words that parallel their established expectations for a well-formed object label in English, then there are two possible outcomes. Infants may only accept the novel English forms and reject the Czech words and the Japanese words. However, it is possible that infants only focus on the legality of sound sequences and do not consider lower-level phonetic cues. If this is the case, they will accept the Japanese forms, but not the Czech words.

Method

Participants. Sixty 12-month-old infants from English-speaking homes were included in the final sample. An additional 16 infants were excluded from the sample for the following reasons: did not complete ($n = 2$), failure to habituate ($n = 6$), technical error ($n = 3$), excessive fussiness ($n = 4$), and parental interference ($n = 1$). Infants were randomly assigned to one of four between-subjects groups: the CVCV English, the CVCV Japanese, the CCVC Czech, or the CCVC English word group. See Table 1 for demographics. Infants did not differ significantly in age ($p = .33$) or productive vocabulary size across groups ($p = .70$).

Stimuli. The visual stimuli were videotapes of three novel objects (see Figure 1). The auditory stimuli presented during habituation and test trials consisted of eight exemplars of each of the following words: two novel CVCV English words: *mido* [maɪdoʊ] and *panu* [pænu]; two CVCV Japanese words: *sika* [ʃika] (deer), and *hashi* [haʃi] (chopsticks); two CCVC Czech words: *ptak* [ptɑk] (bird) and *svet* [svɛt] (world); and two novel CCVC

Table 1
Mean Ages, Mean Productive Vocabulary Size, and Gender Distribution by Group

Group	*n*	Mean age (*SD*)	Age range	CDI production (*SD*)	Gender
CVCV English	15	12.43 (.27)	12.03–12.95	2.33 (2.69)	6 girls
CVCV Japanese	15	12.61 (.35)	12.07–12.95	2.93 (2.98)	8 girls
CCVC Czech	15	12.60 (.27)	12.03–12.95	3.6 (2.97)	8 girls
CCVC English	15	12.49 (.33)	12.06–12.95	3.13 (3.25)	6 girls

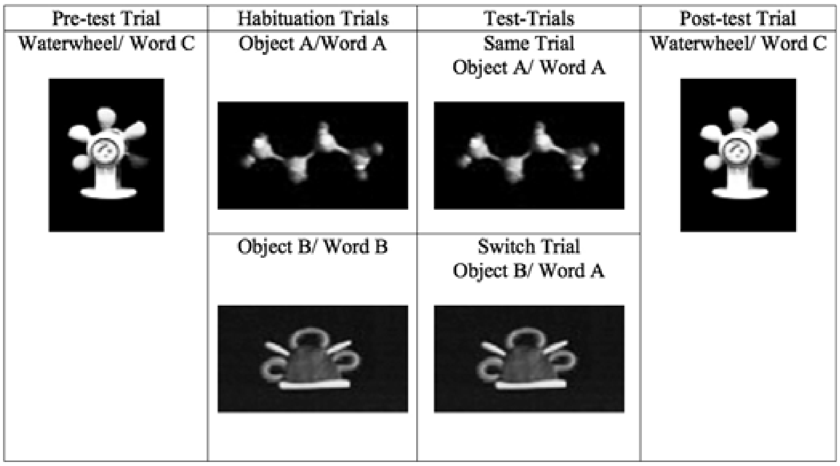

Figure 1. Outline of switch task design.

English words: *snet* [snɛt] and *plok* [plɑk]. The pre- and posttest trials words were: *tega* [teɪga] (CVCV English word group), *tega* [tega] (CVCV Japanese word group), *dluh* [dluɦ] (CCVC Czech word group) and *frim* [frɪm] (CCVC English word group). Using infant-directed speech, female native speakers recorded the English, Japanese, and Czech words (see Table 2 for acoustic measurements of the stimuli).

In order to ensure that non-native words were sufficiently different from English, we asked 27 adults to rate the words on a Likert-type scale (1 = *sounds like a possible English word* to 7 = *does not sound like a possible English word*). Raters heard the words in randomized orders with the sound of piano keys inserted between the words to control for carryover or contrast effects. Adults rated the Japanese ($M = 6.03$, $SD = 1.01$) and Czech ($M = 4.91$, $SD = 1.05$) words as significantly different from the CCVC English ($M = 2.91$, $SD = 0.79$) and CVCV English ($M = 3.24$, $SD = 1.34$) words in the expected direction (ps $< .001$). There were no significant differences in the ratings of the CCVC English ($M = 2.91$, $SD = 0.79$) and CVCV English ($M = 3.24$, $SD = 1.34$) words ($p > .20$).

Table 2
Fundamental Frequency (F0) and Duration (second) for Stimuli

Language/syllable structure	Word	F0 (*SD*)	Duration (*SD*)
Experiment 1			
English/CVCV	mido	299.75 (18.09)	1.34 (.06)
	panu	302.5 (11.6)	1.19 (.08)
Japanese/CVCV	hashi	256 (66.15)	0.65 (.07)
(differ phonetically)	sika	263.12 (46.29)	0.66 (.06)
English/CCVC	plok	291.62 (21.24)	0.85 (.04)
	snet	322.12 (18.7)	0.86 (.03)
Czech/CCVC	ptak	318.75 (8.13)	0.80 (.05)
(illegal phonotactics)	svet	325.75 (29.2)	0.96 (.05)
Experiment 2			
English/CVCV	mido	247.33 (6.47)	0.65 (.04)
	panu	286 (21.08)	0.74 (.03)
Japanese/CVCV	hashi	303 (20.68)	0.71 (.07)
	sika	368.5 (15.08)	0.65 (.06)

Apparatus. Testing took place in a dimly light sound-proof room. While sitting on their parent's lap or in a high chair, infants faced a 122 cm × 91.5 cm video monitor. During testing, each parent wore headphones and listened to masking music.

All words were presented at a consistent volume (65 dB, ±5 dB) across groups from a speaker located directly below the monitor. Infants were recorded and video was used for frame-by-frame coding and primary coding. The experiment was run using the Habit X 1.0 program (Cohen, Atkinson, & Chaput, 2004).

Procedure. Infants were tested using a modified habituation paradigm known as the switch task (Werker, Cohen, Lloyd, Casasola, & Stager, 1998; see Figure 1). The procedure followed for all four groups was identical—all that varied across groups were the words presented. Each infant was shown the same sequence of trials, which were each 20 s in duration. The pretest and posttest trials, which consisted of a novel word–object pairing, were included to control for fatigue or disinterest.

Testing began with a pretest trial followed by the habituation phase, during which infants were presented with two sets of word–object pairings. Infants in the CVCV English word group were presented with two CVCV English word–object combinations presented alternatively (e.g., *mido* paired with Object A and *panu* paired with Object B). Infants in the CVCV Japanese word group were presented with two CVCV Japanese word–object combinations presented alternately (e.g., *hashi* paired with Object A and *sika* paired with Object B). Infants in the CCVC Czech word–object group were presented with two Czech word–object combinations presented alternately (e.g., *svet* paired with Object A and *ptak* paired with Object B). Finally, infants in the CCVC English word group were presented with two sets of novel CCVC English word–object pairings presented alternatively (e.g., *snet* paired with Object A and *plok* paired with Object B). For each group, the particular word that was associated with a particular object was counterbalanced. All groups were presented with these word–object pairings in a semirandom order until looking time decreased to a set criterion (65%) or until a maximum of 24 trials were completed. The habituation criterion was met if an infant decreased his or her looking time by at least 65% (a 35% decrement) of that of the first block of four trials during any of the following five blocks. If the infant reached the habituation criterion before the sixth block of four trials, then the test phase would begin. Infants that did not reach the habituation criterion were excluded from the final analyses.

Following habituation, infants were presented with two test trials in counterbalanced order: the *same* trial and the *switch* trial. During the same trial, infants were presented with a familiar object–word (e.g., *mido* paired with Object A). During the switch trial, infants were presented with a familiar object and word but with the familiar pairing violated (e.g., *mido* paired with Object B). These trials were followed by the posttest trial.

Coding. Online coding was only used to determine if infants habituated to the word–object pairings. For the critical trials (i.e., pretest trial, last four habituation trials, two test trials and the posttest trial), infants' looking times were coded on a frame-by-frame basis. To measure interrater reliability, 20% of the data ($n = 12$) was coded by a second coder. Intraclass correlation (ICC) coefficients for looking time responses were .99 (ps < 001).

Results

To ensure that infants regained attention at the end of the task, we examined looking time during the pretest, posttest, and last habituation block (see Table 3. Results of a 4 (group) × 3 (trial: pretest, posttest, last habituation block) ANOVA yielded only a main effect of trial ($p < .001$). Infants' looking times did not differ significantly between the pretest trial and the posttest trial ($p > .99$) but they did look significantly longer to the pretest compared to the last block of habituation trials and to the posttest compared to the last block of habituation trials (ps < .001). A comparison of the number of habituation trials revealed no significant differences across groups ($p = .19$). Together, these analyses indicate that infants in all groups recovered from habituation and did not differ in the number of trials required to habituate.

Table 3
Mean Looking Times and Number of Habituation Trials by Group for Pretest, Posttest, and Last Habituation Block

Group	Pretest	Posttest	Last habituation block	Average no. of habituation trials
CVCV English	15.09 (3.86)	15.45 (4.52)	6.78 (2.39)	13.87
CCVC Japanese	16.19 (3.41)	17.40 (2.67)	6.53 (1.37)	16.00
CCVC Czech	15.99 (3.25)	15.28 (4.03)	6.83 (2.06)	12.53
CCVC English	18.47 (1.79)	17.61 (2.45)	6.67 (2.10)	15.73

Note. Standard deviations in parentheses.

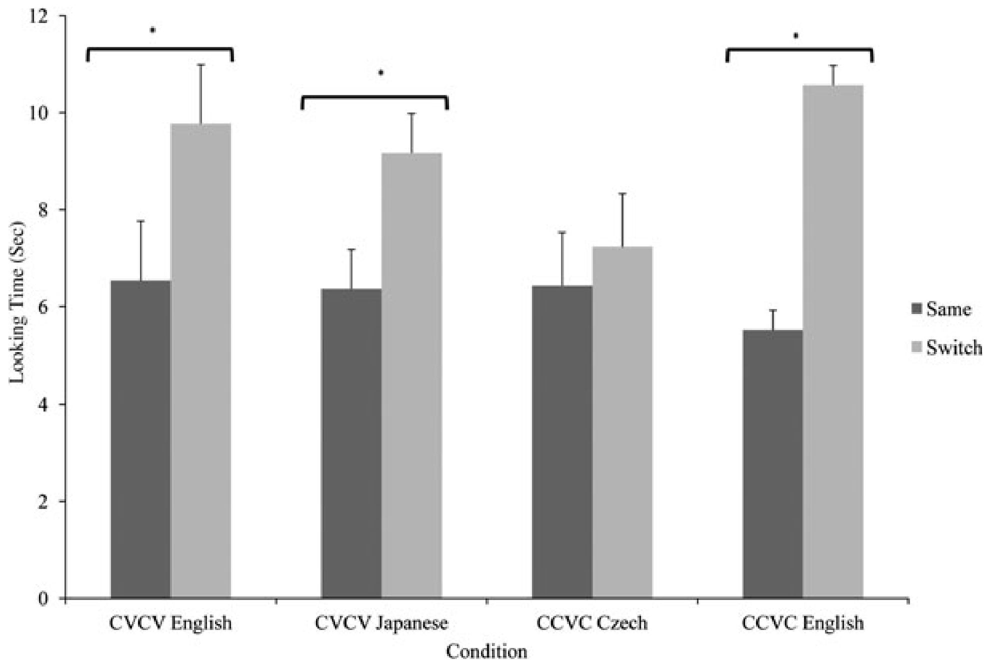

Figure 2. Differences in mean looking time for the same and switch trials by group.
*$p < .05$.

The primary analyses compared infants' performance during the same and switch test trials across groups. See Figure 2 for mean looking times by test trial and group. Recall that if infants have associated the words with the novel objects, their looking times should be significantly longer during the switch trial than during the same trial. A 4 (group) × 2 (trial type: same, switch) mixed factor ANOVA yielded a significant main effect of trial type, $F(1, 56) = 37.90$, $\eta_p^2 = .40$, $p < .001$, and a Group × Trial Type Interaction, $F(1, 56) = 3.28$, $\eta_p^2 = .15$, $p = .03$. To understand the source of this interaction, pairwise comparisons were used to compare looking times during the switch and same trials for each group. Results indicated that infants looked significantly longer during the switch trial versus the same trial in the English CVCV word group, $t(14) = 3.53$, $d = .733$, $p < .01$; the English CCVC word group $t(14) = 5.17$, $d = 1.78$, $p < .001$; and the Japanese CVCV word group, $t(14) = 2.86$, $d = .88$, $p < .05$. The majority of infants in the English CVCV group (13/15), in the English CCVC group (14/15) and in the Japanese CVCV group (11/15) looked longer to the switch trial than the same trial. In contrast, infants in the CCVC Czech word group did not look significantly longer during the switch trial versus the same trial, $p > .43$, indicating that 12-month-olds did not map Czech words to objects. Here, only 7 of 15 infants looked longer to the switch trial than the same trial.

Discussion

These results demonstrate 12-month-olds accept CVCV English, CCVC English, and CVCV Japanese words, but not CCVC Czech words that are phonotactically illegal in English, as labels for objects. This pattern likely reflects infants' sensitivity to the phonotactic properties of their native language and indicates that they will not map illegal word forms to objects in an associative task. However, the finding that infants will accept Japanese words as labels suggests that their word learning is not constrained by phonetic differences on the realization of phonemes. It is possible, however, that infants were simply not sensitive to the differences in the English and Japanese CVCV forms, even though adults rated the Japanese forms used in this study as not native-like. To address this possibility, we asked whether infants prefer CVCV English over CVCV Japanese word forms.

Experiment 2

Method

Participants. Sixteen infants were included in the final sample (9 female; mean age = 12.51, SD = 0.31).

Materials. Six tokens of each of the two CVCV English words (i.e., *mido* and *panu*) and six tokens of each of the two CVCV Japanese words (i.e., *sika* and *hashi*) used in Experiment 1 were presented. To control for any influence of voice quality, both sets of words were recorded by a Japanese-English bilingual female speaker (see Figure 1 for F0 and durations).

Apparatus and procedure. The apparatus used for testing was identical to Experiment 1. Infants were tested using an infant-controlled sequential looking preference (SLP) procedure (Cooper & Aslin, 1990, 1994; Vouloumanos & Werker, 2004). Each trial took the following form: Infants first were presented with a flashing colored ball to attract their attention to the screen. Once the infant fixated on the screen, the trial began. On each trial, a static black-and-white checkerboard was displayed while one set of words was played from a speaker below the screen. Stimulus presentation on each trial was infant controlled. That is, the sound and checkerboard were presented for as long as the infant looked at the screen. When the infant looked away continuously for longer than 1 s, the stimulus presentation terminated and the next trial began.

Each infant was presented with a total of 10 trials, 5 English word trials alternated with 5 Japanese word trials. A full trial consisted of 14 tokens chosen randomly from the set of 12 tokens, separated by 300- to 500-ms silence, for a maximum length of 20 s per trial. For any given trial, tokens were ordered in a semirandom order so that every fixed window of four tokens included at least two of each word (i.e., two *mido* exemplars and two *panu* exemplars and two *sika* exemplars and two *hashi* exemplars). For half the infants ($N = 8$), trial order was reversed.

Infants' looking times were coded on a frame-by-frame basis. Interrater reliability for 20% of the data ($n = 3$) was high (ICCs = .99, $ps < .001$).

Results and Discussion

As is standard with the SLP procedure, the first trial was excluded from the analysis (Cooper & Aslin, 1994). Since order of presentation was counterbalanced, an equal number of English and Japanese trials were excluded. Using the remaining nine trials, we calculated each infant's total looking time for each type of word, English or Japanese. We then compared looking time during the English versus Japanese trials. Results indicated that infants looked significantly longer during the English trials ($M = 5.62$, $SD = 2.98$) than the Japanese trials ($M = 3.67$, $SD = 1.73$), $t(15) = 3.82$, $d = 0.80$, $p < .01$.

The results demonstrate that 12-month-olds are sensitive to the phonetic distinction between CVCV English words and CVCV Japanese words and show a preference for listening to CVCV English words over CVCV Japanese words.

General Discussion

Infants' shift from language-general to language-specific processing has been well documented during the 1st year of life. The results of these experiments offer insight into whether this attunement to the properties of their native language is reflected in infants' willingness to attach words from different languages to objects in an associative learning task. When presented with a variety of word forms, 12-month-olds will attach novel CVCV English, CVCV Japanese (even though these are phonetically different from English), novel CCVC English words, but not CCVC Czech words (which are phonotactically illegal in English), to objects when presented in an associative learning paradigm. These results demonstrate that by 12 months of age, infants are beginning to apply their language-specific phonotactic knowledge to their acceptance of word forms. That is, they will not map words that violate the phonotactics of their native language to objects.

Infants treated the English and Japanese words similarly in that they mapped both types of words to the objects. This similarity in performance suggest that that infants recognized both words as object labels that parallel their established expectations of what constitutes as a word. That is, although the Japanese words are phonetically different from English, they did not differ enough from infants' native language to be dismissed as a potential label. This finding is impressive, given that same-aged infants prefer listening to English forms over Japanese words and adults rated the Japanese words as different from English. In contrast, the CCVC Czech words violated English phonotactics with illegal consonant cluster onsets (i.e., /pt/ and/ sv/). The finding that infants mapped both CVCV English and CCVC English words to objects, suggests that it is the illegal consonant clusters, not the syllable structure of the Czech words, that influenced infants' willingness to map these words to objects.

Given that infants have honed in on native-language sound combinations (phonotactics), it is quite possible that their failure to map these illegal forms to objects stems from a lack of similarly structured forms in their lexicon. That is, since these forms violate English phonotactics and no such forms exist in the infants' lexicon, they are resistant to mapping the Czech words to objects. An alternative, yet compatible, explanation is that lexical neighborhood density (Bailey & Hahn, 2001) is driving English infants' resistance to map Czech words onto novel objects. A neighborhood is determined by the addition, subtraction, or substitution of a sound (e.g. Charles-Luce & Luce, 1990; Vitevitch & Luce, 1998). Words that have less dense neighborhoods, in this case the Czech forms, will be unlikely word candidates. While both possibilities can help to explain why infants do not map the Czech forms, given the size of a 12-month-old lexicon (CDI: expressive < 4; mean receptive = 19.95), neighborhoods at this stage of development may be sparse. However, further research is required to determine if this is indeed the case.

Our findings demonstrate that while phonotactics do constrain infants' word–object mappings, differences in the phonetic realization of the forms do not. The phonetic realization of the Japanese words used in our study differs only in subtle ways from English. Infants' acceptance of these forms is consistent with findings demonstrating that 9-month-olds are tolerant of novel words produced in accented speech (Schmale & Seidl, 2009). Thus, 12-month-olds may not have fully refined their preferences fully to focus exclusively on English phonology.

It remains to be determined whether infants would ever fully narrow their focus or whether some phonological variation from their native language would remain acceptable. Studies examining recognition of familiar words suggest that older infants rely on their abstract sound categories (phonemes) when confronted with words that vary in their pronunciation (phonological constancy; Best, Tyler, Gooding, Orlando, & Quann, 2009). This reliance on phonemes helps to explain the minimal pair findings where 17-month-olds, but not 14-month-olds, detect a mismatch in the word–object label (e.g., *bih* and *dih*; Stager & Werker, 1997). That is, as the lexicon develops, infants can use phonemes to direct attention to the relevant information in a word–object associative task (Werker & Curtin, 2005). Thus, the changing system itself might obscure sensitivity to phonetic information in word learning.

In sum, we demonstrate that infants have acquired a significant amount of knowledge about their native language sound system by the end of the 1st year of life. This knowledge is reflected in their willingness to attach novel words to novel objects. Indeed, if a form is phonotactially illegal in the language, infants will not map this form to a novel object. This suggests that experience with the native language influences what is considered an acceptable label.

References

Bailey, T. M., & Hahn, U. (2001). Determinants of word-likeness: Phonotactics or lexical neighborhoods? *Journal of Memory and Language*, *44*, 568–591.

Best, C. T., Tyler, M. D., Gooding, T. N., Orlando, C. B., & Quann, C. A. (2009). Development of phonological constancy: Toddlers' perception of native- and Jamaican-accented words. *Psychological Science*, *20*, 539–542.

Bosch, L., & Sebastian-Galles, N. (2003). Simultaneous bilingualism and the perception of a language-specific vowel contrast in the first year of life. *Language and Speech*, *46*, 217–243.

Charles-Luce, J., & Luce, P. A. (1990). Similarity neighborhoods of words in young children's lexicons. *Journal of Child Language*, *17*, 205–215.

Cohen, L. B., Atkinson, D. J., & Chaput, H. H. (2004). *Habit X: A new program for obtaining and organizing data in infant perception and cognition studies (Version 1.0)*. Austin: University of Texas.

Comrie, B. (1990). *The world's major languages*. New York: Oxford University Press.

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

Cooper, R. P., & Aslin, R. N. (1994). Developmental differences in infant attention to the spectral properties of infant-directed speech. *Child Development*, *65*, 1663–1677.

Curtin, S., Fennell, C., & Escudero, P. (2009). Weighting of acoustic cues explains patterns of word-object associative learning. *Developmental Science*, *12*, 725–731.

Friederici, A. D., & Wessels, J. M. I. (1993). Phonotactic knowledge of word boundaries and its use in infant speech perception. *Perception and Psychophysics*, *54*, 287–295.

Graham, S. A., & Kilbreath, C. S. (2007). It's a sign of the kind: Gestures and words guide infants' inductive inferences. *Developmental Psychology*, *43*, 1111–1123.

Hollich, G., Hirsh-Pasek, K., & Golinkoff, R. (2000). Breaking the language barrier: An emergentist coalition model of word learning. *Monographs of the Society for Research in Child Development*, *65*, 1–123.

Jusczyk, P. W., Frederici, A. D., Wessels, J., Svenkerud, V. Y., & Jusczyk, A. M. (1993). Infants' sensitivity to the sound patterns of native language words. *Journal of Memory and Language*, *32*, 402–420.

Jusczyk, P. W., Luce, P. A., & Charles-Luce, J. (1994). Infants' sensitivity to phonotactic patterns in the native language. *Journal of Memory & Language*, *33*, 630–645.

Kuhl, P. K., Williams, K. A., Lacerda, F., Stevens, K. N., & Lindblom, B. (1992). Linguistic experience alters phonetic perception in infants by 6 months of age. *Science*, *255*, 606–608.

Mattys, S. L., Jusczyk, P. W., Luce, P. A., & Morgan, J. L. (1999). Phonotactic and prosodic effects on word segmentation in infants. *Cognitive Psychology*, *38*, 465–494.

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

Nazzi, T. (2005). Use of phonetic specificity during the acquisition of new words: Differences between consonants and vowels. *Cognition*, *98*, 13–30.

Nazzi, T., & New, B. (2007). Beyond stop consonants: Consonantal specificity in early lexical acquisition. *Cognitive Development*, *22*, 271–279.

Schmale, R., & Seidl, A. (2009). Accommodating variability in voice and foreign accent: Flexibility of early word representations. *Developmental Science*, *12*, 583–601.

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

Vitevitch, M. S., & Luce, P. A. (1998). When words compete: Levels of processing in perception of spoken words. *Psychological Science*, *9*, 325–329.

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

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.

Werker, J. F. (1995). Exploring developmental changes in cross-language speech perception. In L. R. Gleitman & M. Liberman (Eds.), *Language: An invitation to cognitive science* (2nd ed., pp. 87–106). Cambridge, MA: MIT Press.

Werker, J. F., Cohen, L. B., Lloyd, V. L., Casasola, M., & Stager, C. L. (1998). Acquisition of word-object associations by 14-month-old infants. *Developmental Psychology*, *34*, 1289–1309.

Werker, J. F., & Curtin, S. (2005). PRIMIR: A developmental framework of infant speech processing. *Language Learning and Development*, *1*, 197–234.

Werker, J. F., & Tees, R. C. (1984). Cross language speech perception: Evidence for perceptual reorganization during the first year of life. *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.