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Infant Preferences for Structural and Prosodic Properties of Infant-Directed Speech in the Second Year of Life

Judith Segal and Rochelle S. Newman
University of Maryland

While a large literature discusses young infants' preference for an infant-directed speaking style, few studies have explored preferences after the first year. The present work compares infants' preference for two different properties of IDS speech: prosodic changes (primarily pitch and pitch variability) and structural properties (utterance length; lexical repetition). We found that both 12- and 16-month-old infants continued to prefer listening to speech with the prosodic properties of IDS, but neither age showed any preference for speech with the lexical repetition and short utterances typical of IDS.

One factor that might help infants learn their native language is the special speech register used when speaking to them, referred to as "infant-directed speech" (IDS). IDS is characterized by both acoustic and structural properties that differ from those in typical adult speech (ADS), including changes in pitch (both higher mean fundamental frequency and more variation in F0; Fernald & Mazzie, 1991; Fernald & Simon, 1984) as well as use of shorter utterances and a simpler, more repetitive vocabulary (Bernstein Ratner, 1988; Bernstein Ratner & Rooney, 2001; Broen, 1972; Phillips, 1973; Snow, 1972; Soderstrom, 2007).

These modifications appear to encourage infant attention (Cooper, Abraham, Berman, & Staska, 1997; Fernald, 1985; Pegg, Werker, &

Correspondence should be sent to Rochelle Newman, Department of Hearing & Speech Sciences and Program in Neuroscience & Cognitive Science, University of Maryland, 0100 Lefrak Hall, College Park, MD 20742. E-mail: rnewman1@umd.edu

McLeod, 1992; Werker & McLeod, 1989; Werker, Pegg, & McLeod, 1994). As children are presumably more likely to learn from signals to which they attend, increased attention could provide more opportunities for language learning, particularly in situations with multiple information sources competing for the child's attention. Preferences for IDS have been found with infants from a few days old through 9 months of age (e.g., Cooper & Aslin, 1990, 1994; Werker & McLeod, 1989; see Dunst, Gorman, and Hamby, 2012, for a recent meta-analysis).

For young infants, at least some of this preference appears to be driven by changes in pitch (Fernald, 1985; Fernald & Kuhl, 1987), but far less is known about preferences for IDS in older children (Soderstrom, 2007). Recent studies suggest there may be age-related changes in IDS preference, starting in the second half of the first year of life (Cristià, 2013; Hayashi, Tamekawa, & Kiritani, 2001; Newman & Hussain, 2006). One review suggests "the preference for IDS decreases by the end of the first year" (Saint-Georges et al., 2013), but this does not appear to be a consistent pattern. Newman and Hussain (N&H) found a preference for IDS in infants aged 5 months, but no preference in those aged 9 or 13 months. But Hayashi et al. (2001) found that infants showed a U-shaped pattern, with a preference for IDS at 4–6 months and 10–14 months, but not from 7 to 9 months. And a recent study comparing infants at greater vs. lesser risk for autism (Droucker, Curtin, & Vouloumanos, 2013) found an apparent increase in IDS preference from 6 to 12 months, and no change thereafter.

Although cultural or linguistic differences between American and Japanese infants could account for some of this variability, it may also be the result of differences in test stimuli. Hayashi et al. used natural recordings of a mother speaking to an 11-month-old infant vs. an adult. Infants of different ages could have attended to these stimuli on the basis of different signal properties. Indeed, Hayashi et al. suggested that children shift from attending to signals with the pitch properties of IDS to attending to signals that contain "the structures of native speech" (p. 1197). McRoberts, McDonough, and Lakusta (2009) suggested that by 6 months, infants might be tuned to the linguistic structure (particularly repetition) of IDS. They found that starting at this age, infants do not necessarily attend to IDS that is too complex for them, suggesting the shift might be related to changes in linguistic development, and thus related to vocabulary skill. N&H used very tightly controlled IDS and ADS stimuli differing primarily in pitch alone; if older infants' preferences are driven by structural (rather than just acoustic) properties of the signal, this might explain the lack of any preference in their study.

The current study examined preference for IDS in children aged 12 and 16 months and whether any such preference might be driven by pitch changes as compared to structural properties. We presented children with passages that either did or did not contain the higher and more variable pitch patterns associated with IDS, and either did or did not contain structural properties associated with IDS (restricted vocabulary, short utterances, and more repetition). By manipulating these two properties of IDS independently, we examined both whether infants in their second year of life continue to show a preference for IDS and what properties might drive such a preference.

METHOD

Participants

A total of 60 infants participated, 36 aged 12 months (17 males; range 11;4-13;1) and 24 aged 16 months (14 males; range 15;11–17;22). All were learning English as their native language, had a normal developmental history, and were free of ear infections according to parent report. Data from an additional 27 infants were excluded for fussiness ($N = 16$), parental interference ($N = 2$), falling asleep ($N = 1$), non-native experience ($N = 2$), prematurity ($N = 1$), or failure to turn toward the lights ($N = 5$).

Stimuli

Stimuli consisted of eight short test passages, each recorded in two different manners. Four passages contained infant-directed structural properties (IDS-S) and four contained adult-directed structural properties (ADS-S). IDS-S passages had shorter sentences, with less varied vocabulary and more repetitions of focal content words. Each passage was presented in two prosody conditions: infant-directed (IDS-P, with a higher average fundamental frequency, slower speech, and more fundamental frequency variability) and adult-directed (ADS-P).

Test passage content was developed to reflect the natural acoustic and structural properties of mothers' speech to infants of the appropriate age and to adults. To help design appropriate stimuli, 13 mothers were recorded both while playing with their 10- to 13-month-old infants and while speaking to an adult. Measures of mean length of utterance (MLU) and type/token ratio (TTR; the ratio between the number of different words used (types) and the total number of words spoken, an indicator of lexical diversity vs. repetitiveness) were taken from these mothers, and the infant-directed test stimuli were designed to fall within the range of those values. Surprisingly, these mothers did not increase their TTR when speaking to the adult, contrary to typical findings in the literature (Phillips, 1973); this may be an artifact of the particular adult-directed testing situation (parents were interviewed about their children's toy preferences, which encouraged the frequent use of a small number of words). We therefore ensured our IDS passages fell within the mothers' range of values, but ADS passages do not match on TTR; they were instead designed to contain the more typical pattern of less word repetition and a greater variety of words. The mean age of acquisition of words in the passages was roughly equivalent (according to the MRC Psycholinguistic Database, Wilson, 1988, mean AOA was 194 days for IDS-S passages compared to 204 days for ADS-S passages).

A native speaker of English recorded all passages in both an infant-directed and adult-directed style using a Shure-SM51 microphone without an infant present. Recordings were digitized and matched for average (RMS) amplitude and duration (average duration: 30.68 sec). Care was taken to ensure that all ADS-P passages had similar mean pitch, pitch range, and average syllable duration, regardless of structure type; likewise, all IDS-P passages had similar mean pitch and pitch ranges, regardless of structure type, although they did differ slightly (but not significantly) in average syllable duration. Care was also taken to ensure ADS-P and IDS-P passages differed from each other in mean pitch and pitch ranges, regardless of structure type, as well as in average speaking rate.

As expected given the MLU differences, ADS-S passages had longer sentences (in terms of duration) than IDS-S (4.3 vs. 1.5 sec). Pause durations between sentences were also longer (1.125 vs. 0.595 sec) to keep overall duration matched. However, average syllable duration did not differ across structure types (327 vs. 343 msec, $t(7) = 1.35$, $p > .20$). Syllable duration did differ across prosody types (syllables in the IDS-P passages averaged 355 msec, slower than those in ADS-P passages, 316 msec; $t(7) = 3.68$, $p < .01$).

Measurement of pitch was via PRAAT, treating each of the passages as a stimulus for analysis, with a pitch range from 100 to 600 Hz; these were manually corrected for tracking errors by the second author.

Our goal was to objectively separate these two components of IDS into passages that differed by prosody but not by structure and passages that differed in structure but not prosody; see Appendix A for overall stimulus characteristics, Appendix B for duration measures, and Appendix C for sample passages.

Procedures

We used a variant of the headturn-preference procedure (Kemler Nelson et al., 1995). Infants first took part in a practice phase to familiarize them with the experimental procedure; they heard two musical passages in alteration until they accumulated at least 25 sec of listening time to each. This was followed by a test phase of 16 trials, blocked in groups of four. Each block contained one example of each type of passage (IDS prosody with IDS structure; IDS-P/ADS-S; ADS-P/IDS-S; and ADS-P/ADS-S). Order of items within each block, assignment of passage to block, and assignment of trial to side were randomized. The amount of time infants attended to the sound "source" (an accompanying flashing light) was measured for each passage and compared across passage types. The experimenter and caregiver heard masking music over Peltor aviation headphones to prevent bias. Infants' receptive vocabulary was assessed via the MacArthur-Bates Communicative Development Inventory (MCDI; Fenson et al., 1993).

RESULTS

If Hayashi et al.'s (2001) hypothesis is correct, infants in their second year of life should show a preference for passages containing the structural properties of IDS, but no effect of IDS prosody. If, in contrast, infants continue to attend to the higher and more variable pitch associated with an infant-directed speaking style, they should show an effect of IDS prosody, but not necessarily any effect of IDS structure.

Looking across ages (2 age × 2 structure × 2 prosody mixed-effects ANOVA), we found a strong effect of prosody ($F(1,58)=6.73$, $p = .012$; $\eta_p^2 = .104$), but no other main effects or interactions (all $F < 1$ except the three-way interaction, $F = 1.80$, $p > .15$). Thus, there is no indication of any age-related change. Across all children, there was a general preference for an infant-directed prosodic style (see Table 1), but there was no effect of infant-directed structure. This pattern was comparable across the two ages (Figure 1).

One concern is that the size of prosodic differences in the stimuli might be larger than the structural differences; if so, the null effect for structure could be the result of a smaller underlying stimulus difference. To examine

TABLE 1
Listening Time to Different Passage Types for Each Age Group

	Prosody		*Structure*	
AGE	*Adult-directed*	*Infant-directed*	*Adult-directed*	*Infant-directed*
12 months	8.45 (3.1)	9.22 (3.1)	8.72 (3.5)	8.95 (3.0)
16 months	9.38 (3.8)	10.82 (4.4)	10.08 (3.9)	10.12 (4.3)

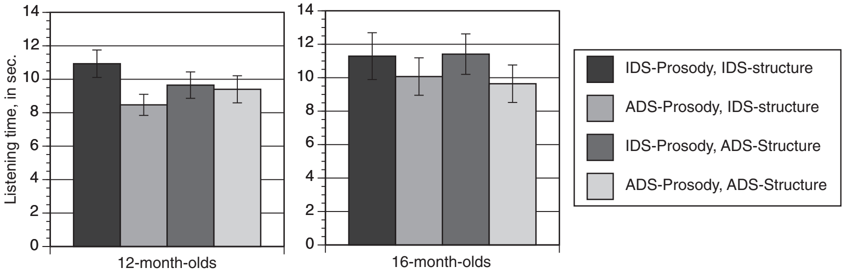

Figure 1 Average looking time to the four types of passages for 12-month-old infants (left) and 16-month-old infants (right). Error bars reflect standard error.

this, we measured effect sizes for the stimulus changes and found it to be largest for MLU (13.3), with similar values for the other dimensions (average pitch = 7.2; standard deviation of pitch = 6.1, TTR = 5.7). The larger effect size for MLU should have resulted in the structural differences being highly obvious to the children. Despite this, they did not influence listening preferences.

We found a correlation between children's preference for infant-directed prosody and MCDI vocabulary scores ($r = .42$, $p < .05$), but this was significant only for 16-month-olds and may be an artifact (particularly as it would not remain significant when controlling for multiple comparisons). There was no correlation between MCDI scores and preference for infant-directed structure ($r = .07$). Thus, there is no indication that older children are decreasing in their preference for IDS prosody or increasing their preference for structural properties of IDS; indeed, if anything, those children who have a greater preference for IDS prosody have acquired a larger vocabulary, supporting (weakly) prior suggestions that such a preference could be useful for language acquisition.

CONCLUSION

The present study explored children's preferences for different aspects of infant-directed speech. Previous studies have consistently found a preference for IDS prosody in children under 9 months (Dunst et al., 2012), but recent work has questioned the existence of this preference in older children (Hayashi et al., 2001; Newman & Hussain, 2006). In the current study, children aged 12 and 16 months listened significantly longer to passages that had the higher mean fundamental frequency and pitch variability typical of IDS, suggesting the preference for IDS prosody continues at least into the second year of life.

Infants did not show a similar preference for the structural properties associated with IDS. Speech to infants is typically characterized by increased redundancy and shorter utterances (Bernstein Ratner & Rooney, 2001; McRoberts et al., 2009), and some have argued that such changes should reduce processing demands and thus be especially beneficial for infants just beginning to map meanings onto word forms. Yet children in the current study did not show any preference for passages that matched these patterns. Even if such changes do prove helpful to infants, they do not appear to influence infant preference.

Hayashi et al. had suggested that older infants' preference for IDS might be driven primarily by structural properties, rather than prosodic ones. These results clearly do not support this hypothesis. However, it is important to note that while this suggestion was one possible explanation for their pattern of U-shaped preferences, they had not provided actual evidence suggesting that infants were no longer attending to prosodic properties of IDS. The present study is the first explicit test of their hypothesis and thus does not conflict with their actual findings, even if it does not support their hypothesis. However, results from the present study do conflict with findings from N&H, who failed to find evidence of IDS preference in infants aged 13 months. It is not clear what factors might underlie this difference. Clearly, differences in the particular stimuli used or the experimental methods might be having an effect. At a first glance, a possible explanation might revolve around the current study's mixture of four types of passages (IDS-P, ADS-P, IDS-S, and ADS-S), which could have biased infants in some way. But N&H also used four passage types: They were interested in exploring the effect of noise on IDS preference and thus presented infants with passages in IDS and ADS both in quiet and in noise. Our two studies thus used a very similar overall design; it may be that preferences for IDS prosody at older ages are particularly dependent on the specific choices of stimuli and their acoustic properties.

In summary, the current study found that infants in their second year of life preferred listening to speech that has the prosodic properties of infant-directed speech, much like their younger counterparts. In contrast, these infants did not show a preference for speech that has the lexical repetition and shorter utterances typical of infant-directed speech. We thus found no evidence for age-related changes in IDS listening preferences.

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REFERENCES

Bernstein Ratner, N. (1988). Patterns of parental vocabulary selection in speech to young children. *Journal of Child Language*, *15*, 481–492.

Bernstein Ratner, N., & Rooney, B. (2001). How accessible is the lexicon in motherese? In J. Weissenborn, & B. Höhle (Eds.), *Approaches to bootstrapping: Phonological, lexical, syntactic and neurophysiological aspects of early language acquisition*. Vol. I. Philadelphia: Benjamins Publishing Company.

Broen, P. A. (1972). The verbal environment of the language-learning child *(ASHA Monographs Number 17)*. Washington, D.C.: American Speech and Hearing Association.

Cooper, R. P., Abraham, J., Berman, S., & Staska, M. (1997). The development of infants' preference for motherese. *Infant Behavior and Development*, *20*, 477–488.

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.

Cristià, A. (2013). Input to language: The phonetics and perception of infant-directed speech. *Language and Linguistics Compass*, *7*, 157–170.

Droucker, D., Curtin, S., & Vouloumanos, A. (2013). Linking infant-directed speech and face preferences to language outcomes in infants at risk for Autism Spectrum Disorder. *Journal of Speech, Language, & Hearing Research*, *56*, 567–576.

Dunst, C. J., Gorman, E., & Hamby, D. W. (2012). Preference for infant-directed speech in preverbal young children. *Center for Early Literacy Learning Reviews*, *5*, 1–13.

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

Fernald, A. (1985). Four-month-old infants prefer to listen to motherese. *Infant Behavior and Development*, *8*, 181–195.

Fernald, A., & Kuhl, P. K. (1987). Acoustic determinants of infant preference for motherese speech. *Infant Behavior and Development*, *10*, 279–293.

Fernald, A., & Mazzie, C. (1991). Prosody and focus in speech to infants and adults. *Developmental Psychology*, *27*, 209–221.

Fernald, A., & Simon, T. (1984). Expanded intonation contours in mothers' speech to newborns. *Developmental Psychology*, *20*, 104–113.

Hayashi, A., Tamekawa, Y., & Kiritani, S. (2001). Developmental change in auditory preference for speech stimuli in Japanese infants. *Journal of Speech and Hearing Disorders*, *44*, 1189–1200.

Kemler Nelson, D. G., Jusczyk, P. W., Mandel, D. R., Myers, J., Turk, A., & Gerken, L. A. (1995). The Headturn Preference Procedure for testing auditory perception. *Infant Behavior and Development*, *18*, 111–116.

McRoberts, G. W., McDonough, C., & Lakusta, L. (2009). The role of verbal repetition in the development of infant speech preferences from 4 to 14 months of age. *Infancy*, *14*, 162–194.

Newman, R. S., & Hussain, I. (2006). Changes in infant preference for infant-directed speech in low and moderate noise by 4.5- to 13-month-olds. *Infancy*, *10*, 61–76.

Pegg, J. E., Werker, J. F., & McLeod, P. J. (1992). Preference for infant-directed over adult-directed speech: Evidence from 7-week-old infants. *Infant Behavior and Development*, *15*, 325–345.

Phillips, J. R. (1973). Syntax and vocabulary of mothers' speech to young children: Age and sex comparisons. *Child Development*, *44*, 182–185.

Saint-Georges, C., Chetouani, M., Cassel, R., Apicella, F., Mahdhaoui, A., Muratori, F., … Cohen, D. (2013). Motherese in interaction: At the cross-road of emotion and cognition? (A systematic review). *PLoS One*, *8*, e78103.

Snow, C. (1972). Mothers' speech to children learning language. *Child Development*, *43*, 549–565.

Soderstrom, M. (2007). Beyond babytalk: Re-evaluating the nature and content of speech input to preverbal infants. *Developmental Review*, *27*, 501–532.

Werker, J. F., & McLeod, P. J. (1989). Infant preference for both male and female infant-directed talk: A developmental study of attentional and affective responsiveness. *Canadian Journal of Psychology*, *43*, 230–246.

Werker, J. F., Pegg, J. E., & McLeod, P. J. (1994). A cross-language investigation of infant preference for infant-directed communication. *Infant Behavior and Development*, *17*, 323–333.

Wilson, M. D. (1988). The MRC psycholinguistic database: Machine readable dictionary, version 2. *Behavioural Research Methods, Instruments and Computers*, *20*, 6–11.

APPENDIX A
TEST STIMULI CHARACTERISTICS

Cells in light gray in the first 4 rows should match one another, as should the values in dark gray, but the light gray and dark gray cells should differ from one another. Moreover, values from the passages (first 4 rows) should fall within the range of values from the mothers' samples (bottom two rows).

Type	*Mean pitch (Hz)*	*Pitch standard deviation*	*MLU*	*TTR*
Infant Prosody/ Infant Structure (IDS-P/IDS-S)	284.66 (*18.2*)	85.78 (*11.9*)	4.29 (*0.34*)	0.408 (*.047*)
Infant Prosody/ Adult Structure (IDS-P/ADS-S)	285.78 (*17.1*)	83.28 (*3.6*)	11.53 (*0.69*)	0.668 (*.044*)
Adult Prosody/ Infant Structure (ADS-P/IDS-S)	198.31 (*5.3*)	44.54 (*5.2*)	4.30 (*0.34*)	0.408 (*.047*)
Adult Prosody/ Adult Structure (ADS-P/ADS-S)	200.39 (*4.2*)	41.95 (*4.9*)	11.53 (*0.69*)	0.668 (*.044*)
Values from 13 mothers' spontaneous IDS (range)	222.1–366.0	77.3–128.0	2.1–5.2	0.22–0.46
Values from 13 mothers' spontaneous ADS (range)	198.2–236.7	40.9–94.2	3.6–12.7	0.25–0.38

MLU: Mean Length of Utterance; TTR: Type/Token Ratio. Numbers in parentheses are standard deviations taken across the four passages. Note that TTR is correlated with passage length, and these passages were much shorter than the mothers' interviews.

APPENDIX B
TEST STIMULI DURATION CHARACTERISTICS

As sentences with an adult-directed structure have significantly larger MLUs, we would also expect them to be longer in overall duration (dark cells, column 1). However, we also expect infant-directed prosody to involve a slower speaking rate, as indicated by a longer average syllable duration (dark cells, column 2).

Type	*Average sentence duration*	*Average syllable duration*
Infant Prosody/Infant Structure (IDS-P/IDS-S)	1.625 sec (*.047*)	373 msec (*32.9*)
Infant Prosody/Adult Structure (IDS-P/ADS-S)	4.497 sec (*.256*)	336 msec (*30.4*)
Adult Prosody/Infant Structure (ADS-P/IDS-S)	1.392 sec (*.121*)	314 msec (*22.0*)
Adult Prosody/Adult Structure (ADS-P/ADS-S)	4.117 sec (*.371*)	319 msec (*31.8*)

APPENDIX C
TEST STIMULI PASSAGES

BATH

Infant Structure

See the water! Feel how warm! Nice water for a bath. Bath time is fun! Time to wash. It's nice and warm. Feel the water. Clean water to wash in. It feels good. You can splash! See the splash. It's time to wash and play. Having a bath is good. The water is clean. Children can play, they can have fun.

Adult Structure

Bath time is good fun for children and it gets them nice and clean, too. They can splash and play before the warm water gets cold. Give them plenty of bath toys. Some bath toys are good for pouring, some for floating, and some for squirting. There are even bath books. Children can learn, play, and wash in the water all at the same time.

DUCKS

Infant Structure

Look at the baby duck. It is yellow. See the little duck. There it is. It is with its mother. They are by the water. You like the little duck. It is soft and cute. What a nice duck. Look there! There is the cute yellow duck. The cute yellow duck is with its mother. There they go!

Adult Structure

This is a story about a cute baby duck and its mother. They walked by the water, but the little yellow duck was scared to go in. The water looked nice and cool, but the duck would not go in. The mother and the baby duck went in together. A soft, fluffy duck is very appealing when it is young.

KITTEN

Infant Structure

See the sweet kitten! See there! There is a cute gray kitten. Come and play. Kittens are soft and small. This one likes milk. Look there! See it drink. Drink the milk! Now it is sleepy. Look at how sweet it is. It's so sleepy! The small gray kitten is so cute. It is nice and soft. It likes to have fun. Let's play!

Adult Structure

Kittens are very cute and sweet when they are small. They run and play, leap and hide, and they are a lot of fun to watch. A kitten likes to curl up into a soft ball when it is sleepy. When it wakes up, it wants to drink milk and play again. A kitten is fun to have and nice to touch, but it can make a big mess.

TEDDY

Infant Structure

Teddy bear is so nice! Look there! See Teddy! He has a red bow. He's sitting on the chair. Go get Teddy! He has soft brown fur. See the soft brown bear. Hi Teddy! There he is! The bear is nice to hug. It's good to hug the soft bear. See how he likes you! See how he likes to play.

Adult Structure

Every child should own a teddy bear. This teddy bear is a nice brown color, with a handsome red bow around his neck. The bear is sitting in a chair while he waits for someone to play with him. He could join a tea party, or take a ride in a car. A teddy bear is a soft toy to hug and a perfect friend for any child.