Infant Dialect Discrimination¹

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¹ This research was supported by the NIH-NIDCD Research Grant (R01DC006235), a grant from the IUPUI Undergraduate Research Opportunities Program, a grant from the IUPUI Summer Research Opportunities Program, and an Educational Enhancement Grant from the IU Graduate Student Organization.
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Abstract. In order to understand speech, infants must differentiate between phonetic changes that are linguistically contrastive and those that are not. Research has shown that infants are very sensitive to fine-grained differences in speech sounds that differentiate words in their own or another language. However, little is known about infants’ ability to discriminate phonetic differences associated with different dialects of their native language. Using a Visual Habituation procedure, 7-, 11-, 18-, 24-, and 30-month-olds were tested on their ability to discriminate two linguistically equivalent variants of the diphthong (/aI/) - one produced in their native dialect (North Midland American English) versus one produced in a nonnative dialect (Southern American English). Seven-month-olds discriminated the variants but 11-month-olds did not. Infants from 18 to 30 months of age did not demonstrate statistically significant discrimination, but they did show a trend toward discrimination with increasing age. The findings suggest that dialect discrimination follows a U-shaped course of development. Because 11-month-olds demonstrated the poorest dialect discrimination performance, we are currently assessing their ability to discriminate linguistically different speech sounds varying in degree of acoustic similarity. Preliminary findings suggest that both language experience and acoustic differences may influence infants’ discrimination of phonetic contrasts in the native language.

Introduction

In order to understand speech and learn language, infants must be able to distinguish between many different speech sounds. Furthermore, infants must be able to discriminate between phonetic contrasts that are linguistically relevant and those that are not. Cross-language speech perception studies demonstrate that the ability to distinguish and categorize phonetic differences is significantly influenced by the phonological qualities of the native language. Young infants are especially sensitive to differences in a wide variety of speech sounds; however, during the second half of the first year of life, linguistic experience begins to modify infants’ ability to distinguish many speech contrasts so that they are generally less attuned to nonnative phonemic distinctions. This perceptual trend usually persists into adulthood (Miyawaki, Strange et al. 1975; Trehub 1976; Werker, Gilbert et al. 1981; Flege and Eefting 1987; Best and Strange 1992). Consequently, most adults have difficulty discriminating nonnative contrasts, even with rigorous laboratory training or early exposure to speech sounds of the foreign language (Lively, Logan et al. 1993; Lively, Pisoni et al. 1994; Pallier, Bosch et al. 1997). The course of early perceptual reorganization is influenced by native language experience and likely influences later language development and speech perception.

The progression from a language-general to a language-specific pattern of speech discrimination has been described for both consonants and vowels. With respect to consonants, investigators have found that younger infants are able to discriminate a wide variety of consonant contrasts, both native and nonnative (Eimas, Siqueland et al. 1971; Holmberg, Morgan et al. 1977; Aslin, Pisoni et al. 1983; Bertoncini, Bijeljac-Babic et al. 1987). However, infants’ sensitivities to nonnative consonant differences begin to decline around 10-12 months of age (Werker and Tees 1983; Werker and Tees 1984; Werker and Lalonde 1988; Best 1993; Best, McRoberts et al. 1995). Infants’ discrimination of vowel contrasts is also evident early in development (Trehub 1973; Trehub 1976; Bertoncini, Bijeljac-Babic et al. 1987; Kuhl, Williams et al. 1992; Polka and Werker 1994; Polka and Bohn 1996). In early studies,
English-learning infants aged one to four months were able to discriminate /aI/-/l/ and /aI/-/l/ contrasts in their native language (Trehub 1973), and they were also able to differentiate between the nonnative [pa]-[pä] which demonstrate the oral/nasal vowel contrast that occurs only in French and Polish (Trehub 1976). Two-month-olds were able to distinguish subtle contrasts like /i/-/I/ in a continuous (versus categorical) manner (Swoboda, Morse et al. 1976). In the native language, six-month-olds were able to distinguish between the vowel distinctions /aI/-/eI/ (Kuhl 1983). Six-month-olds (Kuhl 1979) as well as younger 2- and 3-month-olds (Marean, Werner et al. 1992) were also able to discriminate the contrasts /aI/-/l/ even when listening to talkers varying across age and gender (Kuhl 1979; Clarkson, Eimas et al. 1989; Marean, Werner et al. 1992).

Modification of consonant perception to adapt to language-specific constraints occurs around ten to twelve months of age; however, this change is thought to take place earlier for vowels (at six to eight months of age). When investigators tested English- and Swedish-learning 6-month-olds on their ability to distinguish vowel archetypes from prototypical and nonprototypical examples using the English and Swedish vowels /i/ and /y/, they discovered that discrimination was maintained around nonprototypical exemplars whereas increased generalization was observed around prototypical exemplars. However, this finding, termed the “perceptual magnet effect,” was not found in the younger 4-month-old age group (Kuhl, Williams et al. 1992). Polka and Werker (1994) demonstrated that sensitivity to nonnative vowel distinctions declines earlier in comparison to consonant differences (Polka and Werker 1994). The investigators showed that, among the age groups tested, English-learning 4-month-old infants were better able to discriminate two German vowel contrasts embedded in minimal pairs, /dUt/-/duUl/ and /dyt/-/dut/. English-learning 6- to 8-month-olds, while still showing better discrimination of these foreign contrasts than the 10- to 12-month-olds, were already beginning to show a decline in their ability to discriminate nonnative vowel distinctions (Polka and Werker 1994). Thus, it appears that alterations in the perceptual organization of vowels begin around six to eight months of age.

Regional dialect variation poses an interesting situation in the perception of speech sounds. Dialect differences can occur through variation in the pronunciations of vowels within the native language, though these differences are not linguistically contrastive. Unlike some nonnative vowel contrasts, many dialect-based vowel differences within the native language remain perceivable by adults (Clopper and Pisoni 2001-2002; Clopper and Pisoni 2004a; Clopper and Pisoni 2004b). This may be because, while not linguistically relevant, dialect-based vowel differences are at least meaningful to listeners exposed to more than one dialect. Researchers have shown that adults can distinguish between different dialects of their native language (Clopper and Pisoni 2001-2002; Clopper and Pisoni 2004a; Clopper and Pisoni 2004b). They demonstrated that American English-speaking adults are able to use phonetic properties of different dialects to categorize various talkers into at least three main American English dialect groups (Clopper and Pisoni 2004b). Their research also suggests that adults who have had early exposure to different dialects are more accurate at identifying an unfamiliar talker’s native region, indicating that early exposure to linguistic variation affects dialect discrimination (Clopper and Pisoni 2004a; Clopper and Pisoni 2004b). In another study, perception of differences among six Swedish dialects in native and nonnative speakers was examined. Many nonnative speakers were as proficient as native speakers in dialect discrimination, though native speakers were significantly better than nonnative speakers in naming dialect (Cunningham-Andersson 1996). To date, there have been a few studies investigating the initial development of dialect perception, mainly using fluent speech stimuli. For instance, Nazzi et al. (2000) found that five-month-old infants were able to discriminate American English versus British English when listening to fluent speech (Nazzi, Jusczyk et al. 2000). Another study observed that Australian and American 6-month-olds and Australian 3-month-olds preferred listening to Australian English sentences; this finding that infants are able to generalize across two dialects was attributed to language experience. In addition, the researchers proposed that with age,
infants sort out extraneous phonetic information and cluster American and Australian dialects into the same group (Kitamura, Panneton et al. 2006).

Despite this evidence that dialect variation plays a role in speech perception, little is known about the development of dialect discrimination. In particular, little is known about how infants discriminate specific contrasts that vary with regard to dialect. Therefore, the present study seeks to investigate several questions: Do infants discriminate speech sounds that differ by dialect at the same age as when they can discriminate other contrasts that are linguistically relevant in the ambient language? Is dialect discrimination maintained throughout development? Or, does the ability to discriminate dialect differences develop in a similar way as other phonetic differences (that is, do individuals lose the ability to discriminate contrasts that are not relevant to them)?

Experiment 1: Dialect Discrimination in Younger Infants

Experiment 1 was conducted in order to investigate 7- and 11-month-old infants’ ability to discriminate the North Midland American English and Southern American English dialect pronunciations of the word “pine,” which differ primarily in the vowel sound /aI/. The 7-and 11-month-old age groups were selected because several studies have shown that infants at about 6-8 months of age are able to discriminate most contrasts but by 10 months of age have declined in their ability to discriminate many nonnative contrasts. The diphthong /aI/ was used to test the infants because it is one of the most prominent differences between the North Midland and Southern American English dialects (Wolfram and Schilling-Estes 1998; Clopper 2000). For instance, Southern talkers tend to produce less diphthongization of the /aI/ sound than talkers of other dialects (Wolfram and Schilling-Estes 1998; Clopper and Pisoni 2004b). Consequently, listeners generally use the /aI/ diphthong in order to identify and distinguish between talkers of the North Midland and Southern American English dialects (Clopper and Pisoni 2004b).

Methods

Participants

Twenty American 7-month-olds (12 males and 8 females) and twenty American 11-month-olds (8 males and 12 females) served as participants. The infants were all from monolingual American English-speaking homes in central Indiana. The mean age for the 7-month-olds was 6.76 months (SD = 0.55, range = 6.02 months – 7.76 months), and the mean age for the 11-month-olds was 11.21 months (SD = 0.52, range = 10.43 months – 11.97 months).

Stimuli

The auditory stimuli consisted of repetitions of different tokens of the word “pine” in the North Midland American English and Southern American English dialects. The repetitions were spoken by a female speech-language pathologist who was originally from North Carolina and had lived in Indiana for the past four years. She was capable of speaking in the North Midland American and Southern American English dialects. The visual stimuli consisted of the same checkerboard pattern displayed concurrently with all auditory stimuli.

Acoustic analyses were performed in order to determine that the /aI/ diphthong was different between the North Midland and Southern dialects. In order to analyze the auditory stimuli and to characterize diphthongization of the vowels, the computer program Praat (version 4.1.28) was used. All of
the analyses were done using Praat’s standard settings. Two tokens of “pine” in the North Midland dialect and two tokens of “pine” in the Southern dialect were used. The durations of the tokens of “pine” in the North Midland dialect were 706 ms (token 1) and 691 ms (token 2), and the durations for the tokens of “pine” in the Southern dialect were 653 ms (token 1) and 725 ms (token 2). The durations of the vowel sound /æ/ of “pine” in the North Midland dialect were 346 ms (token 1) and 339 ms (token 2). The durations of the vowel sound /æ/ of “pine” in the Southern dialect were 334 ms (token 1) and 394 ms (token 2).

To characterize the diphthongization of the vowels, the second formant (F2) of the vowel was measured. The change in F2 has been found to most clearly reflect the difference in diphthongization between the North Midland and Southern dialects (Clopper and Pisoni 2004b). The second formant of the vowel was measured at two temporal points, one-third and two-thirds into the vowel. Then, the difference between the formant measurements at these two points was determined (i.e. F2(2/3) – F2(1/3)). For the vowels in the North Midland dialect, ∆F2 was 410 Hz (token 1) and 494 Hz (token 2). For the vowels in the Southern dialect, ∆F2 was 45 Hz (token 1) and 45 Hz (token 2). These analyses show a greater ∆F2 in the North Midland dialect than the Southern dialect, which is consistent with other investigators’ measures of ∆F2 in these dialects (Clopper and Pisoni 2004b).

**Apparatus**

The experiment was conducted in a sound booth. A 55’’ wide-screen television screen was located inside a panel at the front of the sound booth. There was a small hole above the panel through which a video camera was placed in order to watch and record the infants’ movements. A G4 Macintosh computer running Habit software, which contained the experiment files used to test the infants, was located in a separate room from the sound booth (Cohen, Atkinson et al. 2004). The experimenter could view the subject from a closed circuit television from this room. The computer allowed the experimenter to start and stop the visual and sound stimuli and record and store the information on looking times in a data file.

**Procedure**

The experiment was conducted using a version of the Hybrid Visual Habituation (VH) procedure (Houston and Horn 2007). Infants were seated on their caregiver’s lap in front of a TV monitor. At the beginning of each trial, a video of a baby, which served as the attention-getter, was presented in the center of the screen until the infant oriented to the center. Then, the attention-getter turned off, and a checkerboard pattern appeared concurrently with the auditory stimuli. Each trial continued until the infant looked away for 1 second or until the infant looked for a maximum of 20 seconds. The amount of time the infant looked at the checkerboard while the stimuli were presented was recorded for each trial. The experiment consisted of two phases, the habituation phase and the test phase. During the habituation phase, half of the infants were presented with repetitions of a single token of the word “pine” in the North Midland American English dialect, and half of the infants were presented with repetitions of a single token of the word “pine” in the Southern American English dialect. The habituation phase continued until there was a 50% decrease in looking time over three trials compared to the first three trials. After the habituation criterion was reached, the test phase began. During the test phase, infants were presented with ten “old” trials and four “novel” trials. The old trials consisted of repetitions of the token of “pine” presented during habituation alternating with another token of the word “pine” spoken in the same dialect. The novel trials consisted of repetitions of the old token of “pine” presented during habituation alternating with repetitions of a token of the word “pine” spoken in novel dialect. The first two test trials consisted of a novel trial and an old trial, and the order was counterbalanced across
The remaining twelve test trials occurred pseudorandomly so that the novel dialect set was never presented on two consecutive trials. After the experiment was completed, the infant’s looking times between the “novel” versus “old” dialects were measured and compared.

**Results and Discussion**

Paired t-test analyses were performed to compare the mean looking times to the novel stimulus versus the old stimulus. The 7-month-old infants showed significantly longer looking times to the novel dialect versus the old dialect, \( t(19) = 2.19, p \leq 0.02 \) (one-tailed). The mean looking time to the old dialect was 3.63 s (SD = 1.38), and the mean looking time to the novel dialect was 4.55 s (SD = 2.18). In contrast, the 11-month-old infants did not demonstrate significant differences in looking times to the novel dialect versus the old dialect, \( t(19) = -0.08, p \leq 0.47 \) (one-tailed). The mean looking time to the old dialect was 4.47 s (SD = 1.75), and the mean looking time to the novel dialect was 4.42 s (SD = 2.30). Fig. 1 displays the results for the 7- and 11-month-olds in Experiment 1.

**Figure 1.** Mean looking times to the novel versus the old dialect in 7- and 11- month-olds.

The results suggest that 7-month-olds discriminate the North Midland and Southern American dialectical variations of /aI/ in “pine” but that 11-month-olds do not.

**Experiment 2: Dialect Discrimination in Older Infants and Toddlers**

Adults are able to differentiate between many different dialects of American English. This suggests that the ability to discriminate dialectical variants is regained at some point in development. We explored this possibility in Experiment 2 by investigating 18-, 24-, and 30-month-old infants’ ability to discriminate the North Midland American English and Southern American English dialect pronunciations of the word “pine.” In addition, because older infants and toddlers have more language experience, we
examined whether exposure to the Southern American English dialect influenced their discrimination of the dialectical variants.

**Methods**

**Participants**

Thirty American 18-month-olds (15 males and 15 females), thirty American 24-month-olds (19 males and 11 females), and thirty American 30-month-olds (17 males and 13 females) served as participants. The infants were all from monolingual American English-speaking homes in central Indiana. The mean age for the 18-month-olds was 17.80 months (SD = 0.63, range = 16.61 months – 18.95 months), the mean age for the 24-month-olds was 23.97 months (SD = 0.64, range = 23.03 months – 25.00 months), and the mean age for the 30-month-olds was 29.99 months (SD = 0.74, range = 28.98 months – 30.99 months).

**Stimuli**

These were identical to Experiment 1.

**Apparatus**

This was identical to Experiment 1.

**Procedure**

This was identical to Experiment 1. Additionally, the subjects’ parents and other caregivers were asked to complete a questionnaire. The survey asked the caregivers to estimate the number of hours per week an infant was exposed to the Southern American English dialect by a live speaker and various forms of media (i.e. television, radio, etc.) as well as other demographic information.

**Results and Discussion**

Paired t-test analyses were performed to compare the mean looking times to the novel stimulus versus the old stimulus. The 18-, 24-, and 30-month-olds did not demonstrate significant differences in looking times to the novel dialect versus the old dialect; however, discrimination of the two dialectical variants appeared to approach significance with increasing age. For the 18-month-olds, the mean looking time to the old dialect was 4.53 s (SD = 1.69), and the mean looking time to the novel dialect was 4.81 s (SD = 2.98), t (29) = 0.55, p≤0.30 (one-tailed). For the 24-month-olds, the mean looking time to the old dialect was 3.93 s (SD = 1.69), and the mean looking time to the novel dialect was 4.34 s (SD = 1.87), t (29) = 1.07, p≤0.15 (one-tailed). For the 30-month-olds, the mean looking time to the old dialect was 3.75 s (SD = 2.21), and the mean looking time to the novel dialect was 4.59 s (SD = 3.82), t (29) = 1.48, p≤0.06 (one-tailed). Fig. 2 displays the difference in mean looking times to the novel versus old dialect for the 7-, 11-, 18-, 24-, and 30-month-olds.
Looking Time Difference: Novel vs. Old Dialect

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Mean Looking Time Difference (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 months</td>
<td>800</td>
</tr>
<tr>
<td>11 months</td>
<td>-200</td>
</tr>
<tr>
<td>18 months</td>
<td>200</td>
</tr>
<tr>
<td>24 months</td>
<td>400</td>
</tr>
<tr>
<td>30 months</td>
<td>600</td>
</tr>
</tbody>
</table>

Figure 2. Mean looking time differences to the novel versus the old dialect in 7-, 11-, 18-, 24-, and 30-month-olds.

The results suggest that infants from 11 to 30 months of age do not discriminate between the North Midland American and Southern American English dialect pronunciations of the word “pine.” However, there is a trend toward discrimination with increasing age, which may be due to infants’ maturity and/or exposure to the Southern dialect.

In order to help determine whether dialect discrimination is influenced by exposure to the Southern dialect, analyses of variance (ANOVAs) were performed on the 18- to 30-month-olds. The data for one 30-month-old subject tested later, which was not included in the original paired t-test analyses, was included in these analyses because the participant was exposed to the Southern dialect. Infants who did not return completed questionnaires were not included in the ANOVA evaluations. The results revealed no significant effect of exposure to the Southern dialect on discrimination of dialect, $F(1, 73) = 0.122, p \leq 0.36$ (one-tailed). Furthermore, there was no significant effect of exposure time to the Southern dialect on the older infants’ discrimination abilities, $F(1, 73) = 0.129, p \leq 0.36$. These findings suggest that exposure and exposure time to the nonnative dialect does not necessarily facilitate discrimination of dialects from 18 month to 30 months of age.

**Experiment 3: Linguistic and Acoustic Variability**

Infants at 11 months of age demonstrated the poorest dialect discrimination performance among the age groups tested. We propose two possibilities for this finding: (1) 11-month-olds do not show discrimination of dialect because the dialectical variants are linguistically equivalent or (2) infants at this age are generally less sensitive to acoustic differences in speech sounds. In Experiment 3, we explored these possibilities by assessing 11-month-old infants’ ability to discriminate linguistically different speech sounds varying in degree of acoustic similarity.
Methods

Participants

Thirty American 11-month-old infants (14 males and 16 females) were tested on the words “pine” in the Southern dialect and “pawn” in the North Midland dialect (Group 1). The mean age for these infants was 11.00 months (SD = 0.55, range = 9.97 months – 11.81 months). To date, twelve American 11-month-old infants (5 males and 7 females) have been tested on the words “pine” and “pawn” both in the North Midland dialect (Group 2). The mean age for these infants was 11.35 months (SD = 0.45, range = 10.63 months – 12.07 months). Twenty American 11-month-old infants (9 males and 11 females) were tested on the words “pun” and “pawn” both in the North Midland dialect (Group 3). The mean age for these infants was 10.85 months (SD = 0.58, range = 10.03 months – 12.01 months). Twenty American 11-month-old infants (11 males and 9 females) were tested on the words “pine” and “soil” both in the North Midland dialect (Group 4). The mean age for these infants was 10.99 months (SD = 0.54, range = 10.03 months – 11.65 months). The infants were all from families in central Indiana.

Stimuli

The visual stimulus was identical to Experiment 1.

Each group of infants was tested on two different word pairs. Table 1 shows the participant group and their corresponding testing condition.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>pine (S) vs. pawn (NM)</td>
<td>Group 1</td>
<td>Group 2</td>
<td>Group 3</td>
<td>Group 4</td>
</tr>
<tr>
<td>Group 1</td>
<td>pine (NM) vs. pawn (NM)</td>
<td>pawn (NM) vs. pun (NM)</td>
<td>pine (NM) vs. pawn (NM)</td>
<td>pine (NM) vs. soil (NM)</td>
</tr>
</tbody>
</table>

Table 1. Groups of participants and the corresponding word pairs on which they were tested, where S = Southern American English dialect and NM = North Midland American English dialect.

Acoustic analyses were performed in order to compare the acoustic characteristics of the words and vowels. In order to analyze the auditory stimuli, the computer program Praat (version 4.1.28) was used. All of the analyses were done using Praat’s standard settings. The auditory stimuli consisted of repetitions of different tokens of the words “pine” in the Southern dialect, “pine” in the North Midland dialect, “pawn” in the North Midland dialect, “pun” in the North Midland dialect, and “soil” in the North Midland dialect. The tokens of the word “pine” in the North Midland and Southern dialects were identical to the ones used in Experiment 1. The durations of the tokens of “pawn” were 786 ms (token 1) and 782 (token 2), and the durations of the vowel sound /a:/ in “pawn” were 371 ms (token 1) and 341 (token 2). The durations of the tokens of “pun” were 644 ms (token 1) and 678 ms (token 2), and the durations of the vowel sound /ʌ/ in “pun” were 218 ms (token 1) and 227 ms (token 2). The word “soil” was selected because of its markedly different acoustic qualities from the other words described above, which allow it to be easily differentiated. The durations of the tokens of “pine” were 706 ms and 691 ms, and the durations for the tokens of “soil” were 747 ms and 744 ms. The visual stimulus was identical to Experiment 1.
To characterize the vowels, the first (F1) and second formants (F2) of the vowels were measured. The formants of the vowel were measured at two temporal points, one-third and two-thirds into the vowel. Then, the difference between the formant measurements at these two points was determined (i.e. \( F1(2/3) - F1(1/3) \) or \( F2(2/3) - F2(2/3) \)). Table 2 summarizes the formant measurements for the vowel sound /aI/ the Southern dialect and /aI/, /a:/, and /;/ in the North Midland dialect.

<table>
<thead>
<tr>
<th></th>
<th>F1(1/3) (Hz)</th>
<th>F1(2/3) (Hz)</th>
<th>Percent ∆F1</th>
<th>F2(1/3) (Hz)</th>
<th>F2(2/3) (Hz)</th>
<th>Percent ∆F2</th>
</tr>
</thead>
<tbody>
<tr>
<td>/aI/</td>
<td>989</td>
<td>921</td>
<td>-7%</td>
<td>1707</td>
<td>1752</td>
<td>2%</td>
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<tr>
<td>Pine (S)</td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>/aI/</td>
<td>719</td>
<td>607</td>
<td>-16%</td>
<td>1617</td>
<td>2069</td>
<td>28%</td>
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<tr>
<td>Pine (NM)</td>
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<tr>
<td>/a:/</td>
<td>966</td>
<td>921</td>
<td>-5%</td>
<td>1438</td>
<td>1461</td>
<td>2%</td>
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<tr>
<td>Pawn (NM)</td>
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<td></td>
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<tr>
<td>/;/</td>
<td>1011</td>
<td>989</td>
<td>-2%</td>
<td>1685</td>
<td>1797</td>
<td>7%</td>
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<tr>
<td>Pun (NM)</td>
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</tbody>
</table>

Table 2. Mean formant measurements for the vowel sounds /aI/ in “pine” in the Southern (S) dialect, /aI/ in “pine” in the North Midland (NM) dialect, /a:/ in “pawn” in the NM dialect, and /;/ in “pun” in the NM dialect.

Apparatus

This was identical to Experiment 1.

Procedure

This was identical to Experiment 1.

We initially tested 11-month-old infants (Group 1) using the words “pine” in the Southern dialect and “pawn” in the North Midland dialect. While the two words are linguistically different, the onset of the diphthong /aI/ and the vowel /a:/ are similar acoustically. We then tested Group 2 on the words “pawn” and “pun” in the North Midland dialect. The /a:/ in “pawn” and /;/ in “pun” are acoustically similar and are both back vowels that have an average F1 difference of 57 Hz and an average F2 difference of 292 Hz. Next, we tested Group 3 using the words “pine” and “pawn” in the North Midland dialect to determine the 11-month-olds’ discrimination ability of a diphthong versus a non-diphthong. Finally, we tested Group 4 using “pine” and “soil” in the North Midland dialect. This was presumed to be the least challenging discrimination task, since this word pair demonstrated distinctly different words both linguistically and phonologically.

Results and Discussion

The 11-month-old infants in Group 1 (pineS-pawnNM) did not show a significant difference between the average looking times to the novel stimulus versus the old stimulus \( t(29) = 0.95, p \leq 0.18 \) (one-tailed). The mean looking time to the old stimulus was 4.39 s (SD = 2.32), and the mean looking time to the novel stimulus was 4.82 s (SD = 3.39). Group 2 (pawnNM-punNM) did not show a significant difference between the average looking times to the novel versus old stimulus, \( t(19) = -0.15, p \leq 0.18 \) (one-tailed).
p ≤ 0.44 (one-tailed). The mean looking time to the old stimulus was 5.20 s (SD = 2.80), and the mean looking time to the novel stimulus was 5.14 s (SD = 3.41). Group 3 (pineNM-pawnNM) did not show a significant difference between the average looking times to the novel versus old stimulus, t(11) = -0.89, p ≤ 0.196 (one-tailed). The mean looking time to the old stimulus was 4.99 s (SD = 2.18), and the mean looking time to the novel stimulus was 4.49 s (SD = 1.99). The infants in Group 4 (pineNM-soilNM) showed a significant difference between the average looking times to the novel stimulus versus the old stimulus, t (19) = 3.20, p ≤ 0.003 (one-tailed). The mean looking time to the old stimulus was 3.05 s (SD = 0.89), and the mean looking time to the novel stimulus was 5.21 s (SD = 2.96). Figure 3 shows the results of Experiment 3 and also includes the results of the 11-month-olds from Experiment 1.

**Looking Time to Novel vs. Old Word at 11 Months**

![Figure 3. Mean looking times to the novel versus the old stimulus in 11-month-olds of Experiment 1 and in Groups 1, 2, 3, and 4 of Experiment 3.](image)

These findings suggest that 11-month-olds have difficulty discriminating varying degrees of acoustically similar vowel sounds, regardless of dialect differences, even when these differences affect the linguistic meaning of the words. It seems that the vowel discrimination task still remains the most challenging when the vowels are acoustically similar and linguistically equivalent, as occurs in the case of the words “pine” in the Southern dialect and “pine” in the North Midland dialect. However, 11-month-olds are able to distinguish speech sounds markedly different in their acoustic and linguistic qualities, as in “pine” and “soil.”

**General Discussion**

The results provide evidence that infants at 7 months of age discriminate dialectical differences of linguistically equivalent vowel sounds but that infants at 11 months to 30 months of age do not. Similar to Polka and Werker’s (1994) study using nonnative vowel contrasts, younger infants discriminated vowel contrasts better than older infants. Unlike discrimination of vowel contrasts, however, findings from the present study may suggest that not all non-linguistically relevant vowel
contrasts decline in perceptibility at the same age or earlier than consonants. Although the 11- to 30-month-olds did not show discrimination of the dialect-based vowel variants, there was a trend toward discrimination with increasing age. Interestingly, the present study found that experience with the nonnative dialect in 18-, 24-, and 30-month-olds did not facilitate discrimination of dialect. This finding is similar to the results of studies on perception of vowel contrasts in monolingual and bilingual infants. Bosch and Sebastian-Galles (2003) found that Spanish monolingual, Catalan monolingual, and Spanish/Catalan bilingual 4-month-olds were able to discriminate the Catalan contrasts /e/-/e/ while both monolingual Spanish and bilingual infants at 8 months of age showed decreased discrimination of the contrasts. The 8-month-old bilingual subjects demonstrated a decline in sensitivity to the vowel contrasts despite daily exposure to both languages. Discrimination for bilingual infants was ultimately recovered at 12 months of age (Bosch and Sebastian-Galles 2003). Taken together, the results from this and the present study indicate that it is possible that the speech perception processes in the first few years of life are not the mere outcome of exposure to a specific language or dialects within a language.

The perception and discrimination of both native and nonnative vowels may be influenced by factors other than language-specific constraints. This idea is supported by our findings that 11-month-old infants, who showed the poorest discrimination ability in this study, failed to discriminate linguistically different vowels sounds of similar acoustic quality, whether or not dialect differences were present. Eleven-month-olds were, however, able to distinguish speech sounds markedly different in their acoustic and linguistic qualities, as in “pine” and “soil.” Despite the influence of acoustic variation on discrimination, the discrimination task still seems to be the most challenging for 11-month-olds when the vowels are both acoustically similar and linguistically equivalent, as occurs in the case of the words “pine” in the Southern dialect and “pine” in the North Midland dialect; after 11 months, discrimination of these contrasts does seem to gradually improve with increasing age. These findings suggest that acoustic variability and general developmental maturity may play more significant roles than language experience in the discrimination of vowel sounds than was previously thought.

These findings raise several important developmental questions. First, how general is the developmental pattern found in the present study? Can 7-month-olds discriminate more subtle dialectical contrasts? Can 11-month-olds discriminate any dialectical contrasts? Further studies on other dialectical contrasts would provide valuable information about the generality of this developmental pattern and about the role of phonemically-irrelevant acoustic similarity on infants’ discrimination of dialectical contrasts.

Another developmental question that these findings raise is how and at what age do listeners recover their sensitivity to the dialect contrasts that they lose during infancy? Unlike many nonnative phonemic contrasts, dialect contrasts are perceptible to adult listeners even though they are not linguistically relevant (Clopper and Pisoni 2001-2002; Clopper and Pisoni 2004a; Clopper and Pisoni 2004b). Also, how and at what age do listeners recover their sensitivity to linguistically different yet acoustically similar phonemic contrasts? While discrimination of many nonnative phonemic contrasts declines with age, some studies have demonstrated that listeners eventually become better at discriminating certain nonnative contrasts. Polka and Werker (1994) found that adults, both native and nonnative speakers, were able to discriminate two German vowel contrasts (/Y/-/U/ and /y/-/u/) better than 10- to 12-month-old infants. These findings suggest that discrimination of dialect and of other vowel contrasts are recovered at some point during development and may follow a similar pattern of development as discrimination of at least some nonnative contrasts. Further, how acoustically diverse must linguistically different vowel sounds be in order for 11-month-olds to show discrimination? To address this question, we plan to test 11-month-olds using the words “pine” and “poin” in the North Midland dialect. We know that 11-month-olds can discriminate the words “pine” and “soil,” but will
they be able to discriminate the vowel sounds /aI/ from /oI/ when the beginning and ending consonants are similar?

Finally, do listeners ever learn to discriminate dialects through exposure to them? The findings in the current study do not support the idea that exposure to different dialects aids in dialect discrimination, at least for infants and toddlers. However, the research described by Clopper and Pisoni (2004a, 2004b) suggests that experience with different dialects plays at least some role in dialect discrimination. Further studies with older toddlers and children may help to delineate the developmental time course and role of dialect exposure in becoming sensitive to dialect contrasts.

References


fricative consonants. Meeting of the Acoustical Society of America, Miami Beach, FL.


