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Refining stimulus parameters in assessing infant speech perception using visual reinforcement infant speech discrimination: Sensation level

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Abstract

Background—Speech perception measures have long been considered an integral piece of the audiological assessment battery. Currently, a prelinguistic, standardized measure of speech perception is missing in the clinical assessment battery for infants and young toddlers. Such a measure would allow systematic assessment of speech perception abilities of infants as well as the potential to investigate the impact early identification of hearing loss and early fitting of amplification have on the auditory pathways.

Purpose—To investigate the impact of sensation level (SL) on the ability of infants with NH to discriminate /a-i/ and /ba-da/ and to determine if performance on the two contrasts are significantly different in predicting the discrimination criterion.

Research Design—The design was based on a survival analysis model for event occurrence and a repeated measures logistic model for binary outcomes. The outcome for survival analysis was the minimum SL for criterion and the outcome for the logistic regression model was the presence/absence of achieving the criterion. Criterion achievement was designated when an infant's proportion correct score was ≥0.75 on the discrimination performance task.

Study Sample—Twenty-two infants with NH sensitivity participated in this study. There were 9 males and 13 females, aged 6–14 months.

Data Collection and Analysis—Testing took place over two to three sessions. The first session consisted of a hearing test, threshold assessment of the two speech sounds (/a/ and /i/), and if time and attention allowed, Visual Reinforcement Infant Speech Discrimination (VRISD). The second session consisted of VRISD assessment for the two test contrasts (/a-i/ and /ba-da/). The

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presentation level started at 50 dBA. If the infant was unable to successfully achieve criterion (≥0.75) at 50 dBA, the presentation level was increased to 70 dBA followed by 60 dBA. Data examination included an event analysis, which provided the probability of criterion distribution across SL. The second stage of the analysis was a repeated measures logistic regression where SL and contrast were used to predict the likelihood of speech discrimination criterion.

Results—Infants were able to reach criterion for the /a-i/ contrast at statistically lower SLs when compared to /ba-da/. There were six infants who never reached criterion for /ba-da/ and one never reached criterion for /a-i/. The conditional probability of not reaching criterion by 70 dB SL was 0% for /a-i/ and 21% for /ba-da/. The predictive logistic regression model showed that children were more likely to discriminate the /a-i/ even when controlling for SL.

Conclusions—Nearly all normal-hearing infants can demonstrate discrimination criterion of a vowel contrast at 60 dB SL, while a level of 70 dB SL may be needed to allow all infants to demonstrate discrimination criterion of a difficult consonant contrast.

Keywords

Infant speech perception; visual reinforcement infant speech perception

Introduction

With the widespread acceptance of universal newborn hearing screening and the aim of fitting infants who have hearing loss (HL) with amplification by 6 months of age, a tool to assess speech discrimination abilities in this population is necessary. While the need for this tool is clear, the most commonly utilized tool for this age group continues to be parent questionnaires (Uhler and Gifford, 2014), which do not allow objective examination of speech discrimination. Visual reinforcement infant speech discrimination (VRISD) demonstrates potential clinical utility to examine infant speech discrimination in this population. However, several stimulus parameters need to be explored systematically to provide guidelines before VRISD could be easily implemented in the clinic. This article explored one such stimulus parameter, sensation level (SL).

A recent survey conducted by Uhler and Gifford (2014) revealed that the most commonly used tools for monitoring progress in children with cochlear implants were parent questionnaires, the IT-MAIS/MAIS (Robbins, Renshaw, and Berry 1991) and LittlEARS (Kuhn-Inacker, Weichbold, Tsiakpini, Coninx, D'Haese, 2003). Survey and interview-based tools have limitations. For example, parent questionnaires do not assess discrimination of speech sounds such as minimal pairs (e.g., /a/ from /i/ or /ba/ from /da/), which can be helpful for validation of hearing aid and cochlear implant programming. Furthermore, recent studies have found no meaningful, predictive relationship between parent questionnaires and norm-referenced measures of speech and language development (Hedley-Williams et al., 2012; 2013). Infants with HL may have normal auditory development as measured by parent questionnaires, despite significantly delayed auditory development as measured by language scales such as the Preschool Language Scale (PLS; Zimmerman, Steiner, and Evatt Pond 2009) and the Reynell Developmental Language Scales (Reynell and Gruber, 1990).

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Other speech perception measures that are currently available for young children, such as the Mr. Potato Head Task™ (Robbins 1996) and Early Speech Perception (ESP) test-Low Verbal (Moog and Geers 1990), not only require language, but the ability to identify pictures/objects. Robbins and Kirk (1996) assessed the ability of children with normal hearing (NH) to complete the Mr. Potato Head Task™ (a speech perception test) and found that most children cannot complete it with 100% accuracy until 3 1/2 years of age. Therefore, these measures of speech discrimination are not appropriate for infants and young toddlers.

VRISD has been used for decades to examine speech discrimination skills in infants who have NH and are typically developing. VRISD is a conditioned head turn task, very similar to visual reinforcement audiometry (VRA) except rather than presence or absence of a sound the child is conditioned to turn their head to change in the sound stimuli. Much of this research assesses the development of speech perception and infants' ability to detect particular acoustic cues, comparing these abilities with those of adults (e.g., Aslin 1981; Bull, Eilers, and Oller 1984; Eilers et al. 1984; Eilers et al. 1981). The use of VRISD allows assessment of speech discrimination abilities that is independent of language and is easy to implement in a clinical setting (Gravel 1989; Nozza et al. 1991; Govaerts 2006; Martinez 2008; Uhler et al. 2011). However, to establish clinical guidelines the effects of stimulus parameters such as type, duration, and intensity must be examined in infants with and without hearing loss.

Studies in the adult literature have established that the ability to detect, discriminate, and identify sound is directly related to the presentation level of the speech stimulus (Hirsh et al. 1952; Boothroyd 2008; McArdle and Hnath-Chisolm 2009). It has been well documented that performance increases as a function of presentation level in adults (e.g., McArdle and Hnath-Chisolm, 2009) and that identification of spondee words asymptotes at 15 dB above the detection level of the spondee words (Hirsh et al. 1952). Nozza and his colleagues showed that the relationship between performance on speech discrimination and the presentation level is different in infants and adults (Nozza 1987; 2000; Nozza and Wilson 1984; Nozza et al. 1991). Using VRISD, these investigators assessed speech discrimination abilities of NH infants in quiet and in noise, at several presentation levels. They found that NH infants, between 6 and 8 months of age required a more favorable signal-to-noise ratio and a greater presentation level than NH adults to attain maximum performance. Nozza (2000), furthermore, reported that the lowest SL (level relative to detection threshold) at which infants could discriminate between /ba/ and /da/ was 20–25 dB, which is greater than that required by adults. These findings suggest that assessing infant speech perception at only a single presentation level, as is typically done (Uhler et al. 2011; Fredrickson 2010; Martinez 2008; Eilers 1977; Eilers et al. 1981) may underestimate infant speech perception abilities.

Nozza's (1987) findings regarding a need for higher SL, not simply a higher intensity level, for infants, speak to the need to systematically explore the effect of stimulus intensity in infants. Moreover, the optimal levels will likely vary with the types of speech sound contrasts (Eilers et al. 1984; Eilers 1977 Uhler, 2011; van Wieringen and Wouters 1999). This study addressed the optimal sensation level for vowel and consonant discrimination.

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We hypothesized: (a) assessing speech perception at multiple intensity levels will increase the likelihood that infants will demonstrate criterion of a speech discrimination and (b) the minimum SL for speech perception performance in NH infants will be different for two sound contrasts (/a-i/and /ba-da/).

Methods

Participants

Twenty-two NH infants were recruited for this study. There were 9 males and 13 females. The age at testing ranged from 6 to 14 months (*mean*=10.28, *SD*=2.89). One child was excluded due to abnormal tympanometry at two consecutive visits, resulting in a total of 21 participants. To determine eligibility for inclusion in this study, each candidate completed a hearing assessment (pure tone testing and speech awareness threshold), tympanometry, and a test of auditory skill development (ASC; (Meinzen-Derr et al. 2007). Parents were asked if there was any concern of a secondary disability. Hearing assessment served two purposes: (a) to verify NH sensitivity and (b) to confirm the child's ability to successfully complete a conditioned head turn task. Children had hearing assessed in the soundfield or under insert earphones to speech stimuli and pure tone stimuli (octave frequencies 500–4000 Hz).

The final criteria for inclusion in the speech discrimination procedure were (a) no evidence of significant developmental delays/secondary disabilities per parent report, (b) demonstrated ability to complete a conditioned head turn via VRA, (c) normal tympanometry on the day of testing, and (d) either English or Spanish as the primary language spoken in the home. Criteria for exclusion were (a) a history of chronic middle ear infections and/or (b) hearing loss. Hearing thresholds ranged from 0 to 15 dB HL. Table 1 provides a complete summary of infant characteristics.

Colorado Multiple Institutional Review Board approved this project. Consent was obtained from parents/guardians prior to beginning the research project.

Stimuli

Four stimuli were used for testing: /a/, /i/, /ba/, and /da/. The two contrasts used for the experiment were /a-i/, and /ba-da/ (e.g., Eilers 1981; Boothroyd 1984; Nozza et al. 1991; van Wieringen and Wouters 1999; Fredrickson 2010; Uhler et al. 2011). These contrasts represent different levels of difficulty with the vowel (/a-i/) being easiest and the place of articulation contrast (/ba-da/) being most difficult for both NH children and children with sensorineural HL (Boothroyd, 1984; Martinez et al., 2008). Background stimuli were /a/ and /ba/ and /i/ and /da/ were the targets.

Each stimulus (/a/, /i/, /ba/ and /da/) was 500 ms in duration. The same /a/ stimulus was used for each of the CV stimuli (i.e., it was copied and pasted to the consonant), so as to maintain consistency of the vowel sound. The stimuli were natural speech tokens produced by a female speaker. Several exemplars were produced and then the most monotone were chosen. Selected stimuli were then digitized using a 16 bit analog-to-digital converter (AD Instruments Power Lab/16 SP) at 40 kHz. The stimuli were edited using Goldwave Inc. (St. Johns's, NL, Canada). The stimuli were down sampled at 22050 Hz and edited to 500-msec duration. For consonant-vowel (CV) stimuli, the duration of the consonant was 100-msec and the duration of the vowel was 400 ms. During testing, stimuli were presented with 1200-msec interstimulus interval. Thresholds were obtained for the speech sounds /a/ and /i/ using VRA in the soundfield. Detection thresholds for the vowel stimuli were the same for each participant, even though participant's detection of vowel stimuli varied across subjects. Because the level of CV stimuli (/ba-da/) would be dominated by the level of the vowel, SL was calculated relative to the detection threshold for the vowels. Before each test session, the sound level meter microphone was placed at the approximate level of the infant's head during testing and the stimuli were calibrated to 50, 60 and 70 dBA.

Testing Protocol

Testing was completed in a double-walled sound booth. The digitized speech stimuli were routed to an audiometer for presentation in the soundfield.

Typically two sessions were required to complete the protocol. The first session consisted of the hearing test and, if time allowed, a threshold search was obtained for the speech stimuli. The second visit consisted of the VRISD assessment protocol. The infant was accompanied by their caregiver into the sound booth. The child was either seated on their caregiver's lap or in a high chair in the center of the room. The background stimulus (either /i/ or /da/) was on when the child entered the room. The speaker and visual reinforce video screen were 90° to the right of the child's midline (See Figure 1). An assistant who centered the infant's gaze was positioned in front of the child slightly to the left. The caretaker and the assistant were blinded by music playing through supra-aural headphones.

The evaluator, seated outside the soundbooth in a test room, observed the child through a window. The evaluator initiated trials by pressing a button once the child's attention was directed toward midline. Each trial consisted of three stimuli. Fifty percent of trials were no-change and 50% were change trials as selected through the software; the computer program randomly determined which trial type was presented. If the trial was a no-change trial, three background sounds were presented. If the trial was a change trial, the target sound was presented. At the end of the trial, the background continued. The evaluator indicated whether or not the child executed a head turn toward the speaker by a pressing another button. The VRISD software determined if the child's head turn was a correct response to a change trial or a false positive to a no-change trial. Correct responses were rewarded by visual reinforcement, the presentation of an animated video. Fifteen trials were administered during each contrast assessment.

Once the 15 trials were completed, the evaluator calculated proportion while the child remained in the test booth. If the child reached criterion (≥.75) for the contrast, at the first intensity level (50 dBA), then testing for the first contrast was complete and testing for the second contrast was initiated. The rationale was that a child who can successfully discriminate at a low level, would also be able to discriminate at higher levels (McArdle and Hnath-Chisolm, 2009). However, if the child did not reach criterion at 50 dBA, then the level was increased to 70 dBA and testing resumed. Once 15 trials at 70 dBA were completed, the level was reduced to 60 dBA and 15 trials were completed at that level, regardless of performance at 70 dBA. This process was repeated for the other contrast.

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Therefore, children who did not reach criterion at 50 dBA for either contrast, completed a total of six conditions (/a-i/ and /ba-da/ at 50, 60, and 70 dBA).

In each session, testing continued until all conditions were completed or until the child was too fussy or tired to continue. If a third session was required to complete VRISD, testing continued where the second session had ended.

Results

Twenty-one infants completed the study. Eighteen of the 21 children were able to complete the protocol in two visits. Three participants required a third visit.

To address the optimal SL for vowel and consonant discrimination, we used the Kaplan-Meier estimation procedure (also known as survival analysis; Singer and Willett, 2003). Survival analysis is a set of methods used for analyzing event occurrence data where the outcome variable has two parts: one is event status, and the other is the time to event. In the context of the current study, the event of interest was reaching criterion in VRISD (≥.75), and the second dimension was SL rather than time. Simply stated, if an infant did not discriminate at 50 dBA then that observation was considered to have "survived", and the infant continued testing at both 60 and 70 dBA. Kaplan-Meier analysis provides conditional probability functions to summarize the performance pattern across SL for the participants as a group for the two contrasts.

There are two important considerations in the interpretation of this. First, not all infants were assessed at each presentation level and not all infants reached criterion by the end of testing. This is not an uncommon dilemma in this type of study design. However, the Kaplan Meier approach was designed to provide reliable probability estimates even when the primary outcome is unobserved. It does so by using the valuable information that these children's data contribute regarding the probability of *not* demonstrating the criterion.

Table 2 summarizes the number of infants that reached criterion at each level for the /a-i/ and /ba-da/. For /a-i/ 62% of infants reached criterion at 50 dBA, an additional 14% of infants reached criteria at 60dBA, and an additional 19% of infants reached criteria at 70 dBA. One infant did not reach criterion on /a-i/ at any presentation level. For /ba-da/ 38% of infants reached criteria at 50 dBA, an additional 14% reached criteria at 60 dBA, and an additional 19% of infants reached criteria at 70 dBA. Six infants did not achieve criterion for /ba-da/ at any of the presentation levels.

Table 3 provides the Kaplan Meier probability estimates of reaching criterion across SL and the conditional probability functions are provided in Figure 2. The estimated conditional probability of not reaching criterion by 70 dB SL was 0% for /a-i/ and 21% for /ba-da/. The mean SL at criterion for /a-i/ was 50.83 dBA, 95% CI [46.7, 54.9], and the /ba-da/ contrast had a mean SL of 56.56 dBA, 95% CI [51.5, 61.6]. A log rank test of the two curves showed them to be significantly different (X^2 (1, N = 21) = 4.66, p = 0.03).

Infants who did not reach criterion for one or both contrasts by the end of data collection did not significantly differ from each other in age, gender, or audiometric threshold (Table 4).

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However, there was a significant difference between criterion and no criterion groups in the mean highest SL tested for the /ba-da/ contrast ($F_{(1)}$=10.69, p=0.004). The mean highest SL tested for infants who did not reach criterion was 65 dB versus 51.33 dB for infants who did reach criterion. This difference is not unexpected given that infants without criterion were tested up to the highest presentation level.

To address the study's second question regarding whether there was significant effect of contrast type or SL on predicted criterion, we used a repeated measures logistic regression using Generalized Estimating Equations (GEE). The outcome (criterion) was defined as a discrete variable and the predictor variables (contrast, SL) were included in the model as within-subject factors. The GEE procedure extends the generalized linear model to allow for the analysis of repeated binary outcomes or other correlated observations (Liang and Zeger, 1986). Unlike the general linear model, the GEE procedure accounts for the dependency or correlation between measures by robust estimation of the variances of the regression coefficients (Fitzmaurice et al, 1993; Dunlop, 1994; Hu et al., 1998). The interpretation of estimated regression coefficients and odds ratios (OR) within the GEE framework is in line with standard logistic models. For a detailed description of the equation specifications and calculations for a repeated measures logistic regression model using GEE, the reader is referred to Hu et al. (1998), Burton et al (1998), and Zeger and Liang (1992).

Table 5 summarizes the parameter estimates and hypothesis test statistics for the repeated measures logistic regression model. That analysis demonstrated a significant effect for contrast (OR=2.73, p = 0.009). There was a 2.73, 95% CI [1.28, 5.82], greater likelihood of reaching criterion for /a-i/ than for /ba/-/da/. The standardized effect size for this difference was 0.55, which is considered a large effect (Cohen, 1992). When SL was added to the model, both contrast (OR=3.59, p=0.001) and SL (OR=1.07, p=0.009) were significant predictors of criterion, but there was not a significant interaction (p = 0.203, d = 0.03 [where d is the effect size which is not significant]). In other words, the likelihood of reaching criterion increased as SL increased, and after controlling for SL, the likelihood of reaching criterion for /a-i/ was a 3.59 95% CI [1.67, 7.74] greater than /ba-da/. The standardized effect size for this difference was 0.71.

Discussion

This study was designed to determine whether there is an optimal SL for infants with NH sensitivity to assess infant speech perception using VRISD, and whether the optimal SL differed for two sound contrasts. The results showed that the majority of infants who participated in this research study were able to successfully discriminate at least one of the two speech contrasts. Ninety five percent of infants (20/21) were able to discriminate the /a-i/ contrast at a mean SL of 50.83 SL and 71% of the infants (15/21) were able to discriminate the /ba-da/ contrast at a mean SL of 56.56 SL. Thus, the optimal level for testing /a-i/ discrimination may be around 55 or 60 dB SL, while for /ba-da/ discrimination a level of at least 60 or 65 dB SL may be required.

The findings supported the hypotheses that /a-i/ and /ba-da/ would require different SLs for discrimination. Not only was the average SL at criterion higher for /ba-da/ than /a-i/, but

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fewer infants reached criterion on /ba-da/ than on /a-i/ (These observations, of course are not independent, because the estimate of average level at criterion includes the results of the infants who did not reach criterion at the highest level tested). After controlling for SL, the /a-i/ contrast was 3.59 times more likely to be discriminated than the /ba-da/ contrast. The one infant who was not able to discriminate /a-i/ was also not able to discriminate /ba-da/; no infant who reached criterion on /ba-da/ failed to reach criterion on /a-i/. This pattern of results is also consistent with previous reports (Eilers 1981; Boothroyd 1984; Rossman, 1992; vanWieringen and Wouters, 1999; Fredrickson 2010; Uhler et al, 2011).

It may seem surprising that 29% of NH subjects were unable to discriminate /ba-da/ at the highest presentation level. Infants who did not reach criterion on one or both contrasts did not statistically differ in age, gender, or audiometric thresholds from the infants who reached criterion. However, the “failure” rate observed here is quite similar to that reported in previous studies of consonant discrimination. For example, Nozza (1987) reported that 28% of 6- to 8-month-old infants did not reach criterion on a /ba-da/ discrimination. The failure rate for /a-i/ discrimination here is actually lower than that reported in some studies of vowel discrimination. For example, Kuhl, (1979) reported that 2 of 10 6-month-olds did not reach criterion in a vowel discrimination task.

It is possible that assessing /ba-da/ at a higher SL would have allowed more infants to reach criterion. However, another possibility is that infants may simply require more practice for some speech sound discriminations. Unfortunately, while many laboratory studies may test infants in multiple test sessions, the clinical utility of an assessment that requires multiple sessions would be quite limited. Whether there are other stimulus or procedural manipulations that could help infants to discriminate more readily remains to be determined.

The approach used in this study was an effective and efficient way to determine the optimal SL for infant speech discrimination assessments. Data at three SLs could be obtained from many infants in one test session. Future work will determine whether the procedure is as successful in establishing optimal SL for infants with hearing loss.

Conclusions

Nearly all NH infants can demonstrate discrimination mastery of a vowel contrast at 60 dB SL, while a level of at least 70 dB SL may be needed to allow all infants to demonstrate discrimination mastery of a difficult consonant contrast.

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Abbreviations

VRISD visual reinforcement infant speech discrimination

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VRA	visual reinforcement audiometry
NH	normal hearing
HH	hard-of-hearing
HL	hearing loss
SL	sensation level
ESP	Low Verbal

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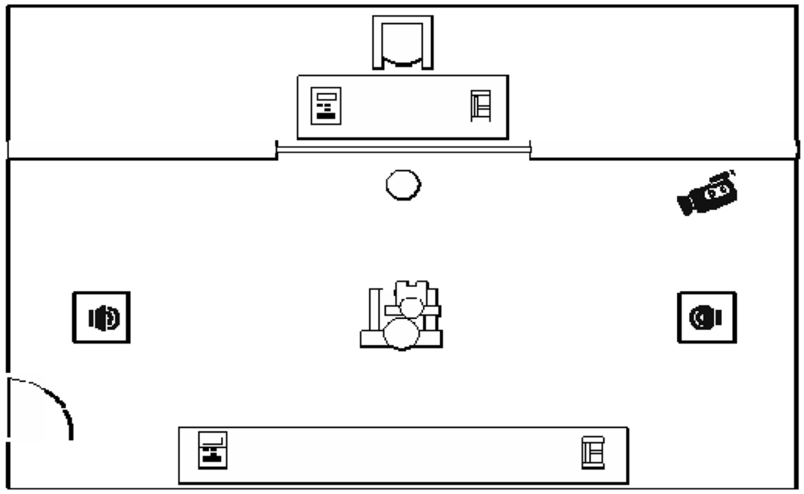

Figure 1.
Booth Configuration for VRISD testing
Note. Booth configuration for VRISD testing. The stimuli were always presented from the right soundfield speaker and the reinforcer is placed directly on top of the soundfield speaker, at 90° azimuth.

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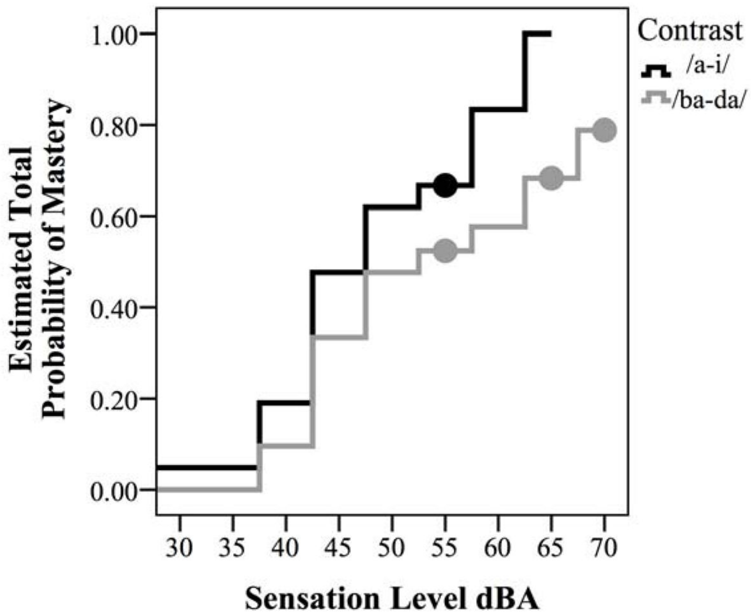

Figure 2.

Probability functions for discrimination criterion across sensation level (SL)

Note. The Kaplan-Meier probability functions for /a-i/ and /ba-da/. The likelihood of achieving the discrimination criterion increases for both contrasts as SL increases with an advantage for /a-i/. The solid dots on the curves mark the maximum SL tested for the infants who did not reach criterion by the end of data collection.

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Table 1

Subject Characteristics

Sample size - N	21
Female- %	62%
Age (months) – Mean (SD)	10.28 (2.89)
Threshold (dBA) – Mean (SD)	5.71 (5.07)
PTA (dB HL) – Mean (SD)	13.25 (2.55)

Note. This table summarizes participant characteristics for NH infants including gender and mean age, threshold, and pure tone average (PTA). Threshold refers to the detection of the sounds employed in the contrasts.

Table 2

Infants Reaching Criterion for Each Contrast by Level

	Level	Infants reaching criterion (n)
/a/-/i/	50	13
	60	3
	70	4
/ba/-/da/	50	8
	60	3
	70	4

Note. Summary of number of infants who reached criterion for each contrast and each level.

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Table 3

Kaplan Meier probability estimates for /a-i/ and /ba-da/

Sensation Level (SL)	No. of infants at the start of the interval (n)	No. of infants with Criterion (m)	Estimated Probability		Total Estimated Probability	
/a-i/			w/o Criterion (1-m/n)	Criterion (m/n)	w/o Criterion	Criterion
35	21	1	.95	.05	.95	.05
40	20	3	.85	.15	.95 × .85 =. 81	.19
45	17	6	.65	.35	.81 × .65 = .52	.48
50	11	3	.73	.27	.52 × .73 = .38	.62
55	8	1	.88	.13	.33	.67
60	6	4	.43	.57	.17	.83
65	3	3	0	1	0	1
/ba-da/						
35	21	0	1	0	.00	0
40	21	2	.90	.10	.91	.10
45	19	5	.74	.26	.91 × .74 = .67	.33
50	14	3	.79	.21	.74 × .79 = .52	.48
55	11	1	.91	.09	.52 × .91 = .48	.52
60	9	1	.89	.11	.42	.58
65	8	2	.75	.25	.32	.68
70	3	1	.67	.33	.21	.79

Note. The Kaplan Meier estimates involve the computing of probabilities of survival (w/o criterion) at any given SL by subtracting the number of subjects reaching criterion from the number of subjects without criterion at a given SL divided by the number of subjects without criterion at that given SL. Total probability of mastering up until a given SL is calculated by multiplying all the probabilities of survival (w/o criterion) at all SLs preceding that point. In other words, cumulative or total probability is calculated using the law of multiplication of probability (Altman et al, 1992).

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Table 4

Infant characteristic comparisons for speech discrimination performance subgroups.

Contrast		Criterion	No Criterion
/a/-/i/	Sample Size - No	20	1
	Age (months) – Mean (SD)	10.49 (2.79)	6.00 (N/A)
	Threshold (dBA) – Mean (SD)	5.25 (4.72)	15 (N/A)
	Maximum SL (dBA) – Mean (SD)	50.25 (9.39)	55 (N/A)
/ba/-/da/	Sample Size - No	15	6
	Age (months) – Mean (SD)	10.79 (2.63)	9.00 (3.35)
	Threshold (dBA) – Mean (SD)	6.00 (5.07)	5.00 (5.48)
	Maximum SL (dBA) – Mean (SD)	51.33 (9.54)	65.00 (5.48)

Note. Infants who did not reach criterion for one or both contrasts by the end of data collection did not significantly differ from each other in age, gender, or audiometric thresholds. N/A= not applicable

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Table 5

Repeated measures logistic regression parameter estimates

			Hypothesis Test			
Parameter	**B**	**Std. Error**	**Wald Chi-Square**	**df**	**Sig.**	**Odds Ratio**
(Intercept)	0.20	0.44	0.20	1	0.655	1.23
[Contrast=/a-i/]	1.28	0.39	10.64	1	0.001**	3.59
[SL]	0.06	0.02	6.74	1	0.009**	1.07
[Contrast=/a/-/i/] by [SL]	0.05	0.04	1.62	1	0.203	1.05

Note. The data in this table represents the logistic regression results using GEE for NH infants (N=21). The predictors included SL, contrast type, and SL by Contrast type interaction. Note, the reference category for contrast was /ba-da/ and SL was mean centered. Df=degrees of freedom

* $p < 0.05$

** $p < 0.01$