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Caregiver and Naïve Listener Report of Vocalizations Produced by a Monolingual Infant versus a Bilingual Infant: A Case Study

by

Diana Williams

A thesis

submitted in partial fulfillment

of the requirements for the degree of

Master of Science in the Department of Communication Sciences and Disorders

Idaho State University

August 2015

Committee Approval

To the Graduate Faculty:

The members of the committee appointed to examine the thesis of Diana Williams find it satisfactory and recommend that it be accepted.

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December 5, 2014

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RE: Your application dated 12/4/2014 regarding study number 4196: Caregiver and Naive Listener Report of Vocalizations Produced by Monolingual Infant versus a Bilingual Infant: A Case Study

Dear Ms. Williams:

I agree that this study qualifies as exempt from review under the following guideline: 4. Analysis of existing data sets. This letter is your approval, please, keep this document in a safe place.

Notify the HSC of any adverse events. Serious, unexpected adverse events must be reported in writing within 10 business days.

You are granted permission to conduct your study effective immediately. The study is not subject to renewal.

Please note that any changes to the study as approved must be promptly reported and approved. Some changes may be approved by expedited review; others require full board review. Contact Tom Bailey (208-282-2179; fax 208-282-4723; email: humsubj@isu.edu) if you have any questions or require further information.

Sincerely,

Ralph Baergen, PhD, MPH, CIP
Human Subjects Chair

Phone: (208) 282-2179 • Fax: (208) 282-4723 • www.isu.edu/research

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Abstract

Early identification of speech/ language impairments is essential in children. As infant vocalization patterns are indicative of future language abilities, the methodology for tracking infant vocalizations should be expanded beyond over-representative, traditional transcription. The new methodologies of caregiver and naïve listener report are suggested to identify more functional phonetic inventories during infant vocal development; thus, the tracking of infant vocalizations may be more readily and easily conducted with these new methods. The present study compared caregiver and naïve listener reports of vocal development between an age- and gender-matched monolingual and bilingual language learner from 6 to 17 months of age. The study answered the question, "Will caregiver and naïve listener reports identify differences in vocalizations dependent upon language learning background; one monolingual, and one bilingual?" Both caregiver and naïve listener reports suggested appropriate vocal development with similarities and differences noted in phonetic inventories. Research and clinical implications will be discussed.

Caregiver and Naïve Listener Report of Vocalizations Produced by a Monolingual Infant versus a Bilingual Infant: A Case Study

Infant vocal abilities have been found to relate with speech and language abilities at older ages (Heimann, Strid, Smith, Tjus, Ulvund, & Meltzoff, 2006; Watt, Wetherby, & Shumway, 2006; Wetherby, Allen, Cleary, Kublin, & Goldstein, 2002; Wetherby, Goldstien, Cleary, Allen, & Kublin, 2003); however, this information has yet to be fully leveraged for clinical practice (Ramsdell, Oller, Buder, Ethington, & Chorna, 2012). Difficulties in utilizing this information stem from the variability within typical infant vocal development (Bates, Dale, & Thal, 1995; Darrah, Hodge, Magill-Evans, & Kembhavi, 2003). Further, difficulties arise when applying normative information to bilingual populations as typical development patterns and norms remain contradictory and the focus of research (Fabiano-Smith & Goldstein, 2010; Hambly, Wren, McLeod, & Roulstone, 2013; Hoff, Core, Place, Rumiche, Señor, & Parra, 2012; Lieven & Stoll, 2013; Mattock, Polka, Rvachew, & Krehm, 2010; Oller, Eilers, Urbano, & Coco-Lewis, 1997). Moreover, the traditional methodology implemented when researching infant vocal development results in over-representative phonetic inventories (Ramsdell et al., 2012). Research suggests caregiver report may identify more representative phonetic inventories from infant vocalizations than traditional methodology. Additionally, recent research identifies a laboratory methodology that may simulate caregiver report (Ramsdell et al., 2012).

Overall, in the present study we attempt to integrate caregiver perspective into knowledge of infant vocal development. Integration of this knowledge may one day

lead to earlier identification of speech and language impairments. Additionally, we further develop laboratory methodology that simulates caregiver report more efficiently and accurately than traditional methods. Specifically, the vocal development of a monolingual and bilingual infant was tracked through caregiver and naïve listener report. It was hypothesized that the caregiver and naïve listener reports would similarly track vocal development in these infants across age, with types of sounds differing between the monolingual and bilingual language learner, corresponding with ambient language background.

Methodological Considerations

Transcription and caregiver report. Traditional methods of tracking infant vocalizations have relied on phonetic transcription, which requires a listener competent in translating spoken sounds and words into the International Phonetic Alphabet (IPA) (Ramsdell et al., 2012). Since the IPA was developed for documentation of mature speech sounds, implementation in infant vocal development is misrepresentative and typically results in over-representative phonetic inventories, given that infants do not produce mature sounds. In an effort to gather more representative inventories and aid in the translation between research and clinical practice, researchers have begun to explore caregiver report of infant vocalizations.

Ramsdell and colleagues (2012) compared caregiver report, phonetic transcription, and naturalistic listener report of vocal productions from eight infants at 8, 10, and 12 months of age. The comparison specifically investigated the degree of similarity between repertoire size and phonological content. Caregivers were asked

during monthly recording sessions “What sounds has your infant produced since your last visit?” (Ramsdell et al., 2012, p.11). Phonetic transcription was completed by four student workers, trained to independently transcribe preselected, randomly ordered utterances. For both caregiver report and phonetic transcription, consonant-vowel syllables were categorized by manner (bilabial, coronal, or dorsal) and place (obstruent, nasal, or semivowel); while vowel productions were all collapsed into a single generic vowel category. Based on these categorizations, all consonant-vowel syllables were classified as one of the following: dorsal semivowel, dorsal obstruent, coronal nasal, coronal semivowel, coronal obstruent, labial nasal, labial semivowel, and labial obstruent plus vowel (Ramsdell et al., 2012). Researchers gathered a list of consonant-vowel syllable shapes identified by caregivers and transcribers at each age of the infants.

Results revealed that phonetic transcription yielded a significantly higher number of syllable types than caregiver report. In addition to smaller inventories, Ramsdell and colleagues (2012) suggest that caregivers identify more representative inventories for their infants than documenting the vocalizations through phonetic transcription. Given that caregivers cannot remember all of the different sounds that their infants produce and do not pay attention to their infants at all times, caregivers likely report sounds that stand out to them as important. For example, a reported sound may be repeated more often or perhaps is more well-formed (speech-like). As such, sounds reported by caregivers are likely to be particularly important in guiding caregiver-infant interaction. Caregivers are likely to reinforce sounds that they report

their infants' to be producing. This reinforcement aids in speech and language development and word learning (Ramsdell, Stuart, & Peterson, in review).

Naïve listener report. Ramsdell and colleagues (2012) developed the naturalistic listener procedure (referred to from here as naïve listener report) as a laboratory methodology to simulate caregiver report. For this method, four laboratory staff members listened to recorded infant utterances and responded to the question, "What sounds/words did the infant produce?" Results revealed naïve listeners to identify syllable and phonetic inventories similar to caregivers with respect to the type and token of sounds reported. As a result, it was suggested that the tracking of infant vocal development may be more readily and easily (and perhaps more validly) conducted using caregiver and/or naïve listener reports than phonetic transcription.

One way to continue exploring the utility of caregiver and naïve listener methodologies is through comparing a monolingual and a bilingual language learner across development. In doing so, we will identify whether or not these listeners recognized differences in the phonetic inventories of the two infants, as the language backgrounds lend themselves to differing inventories.

Linguistic Considerations

The current study incorporated a bilingual Arabic-English learning infant/parent dyad and a monolingual English learning infant/parent dyad. In order to compare the phonetic features of reported vocalizations from these infants, an understanding of the similarities and differences between Arabic and English is necessary, as well as a basic understanding of bilingualism.

Comparison of the Arabic and English languages. Arabic belongs to the Semitic language family; whereas, English belongs to the Indo-Eurpoean language family (Amaryreh & Dyson, 1998). When classifying types of Arabic, context of usage and geography are typically the initial factors considered (Alotaibi & Meftah, 2013). Based on usage, Arabic subdivisions include classical, modern standard, and colloquial Arabic. Colloquial Arabic is the daily spoken language; while modern standard Arabic (MSA) is considered more formal and used in schools and print materials. Based on geography, Arabic subdivisions indicate dialectal differences and include additional divisions within each dialect. English similarly divides into dialectal categories both within the United States and Britain (Alotaibi & Meftah, 2013).

Research on the phonemic inventory of Arabic refers mainly to the MSA (Abushihab, 2010; Alotaibi & Meftah, 2013; Amayreh 2003; Amayreh & Dyson, 1998). The Arabic consonant inventory includes 28 consonants: one liquid, one tap/trill, two glides, eight stops, 13 fricatives, one affricate, and two nasals (Abushihab, 2010; Amayreh, 2003). Emphatic phonemes, unique to Arabic, comprise five of these consonants and are produced with the tongue base retracted into the pharynx (Abushihab, 2010; Alotaibi & Meftah, 2013; Amayreh, 2003). In comparison, the English phonemic inventory includes only 24 consonants: two liquids, two glides, six stops, nine fricatives, two affricates, and three nasals (Singh & Singh, 2006). The English consonants /p/, /v/, /g/, /ʧ/, /ʒ/, and /ŋ/ are excluded from the Arabic phonemic inventory (Abushihab, 2010; Singh & Singh, 2006); while the Arabic consonants /tˤ/, /dˤ/, /sˤ/, /ðˤ/,

/q/, /ʕ/, /x/, /ħ/, and /ɣ/ are excluded from the English phonemic inventory (Amayreh, 2003; Singh & Singh, 2006).

The Arabic language includes six vowels, three pairs characterized by short and long productions (Abushihab, 2010). One set of each paired vowels is characterized as follows: front, high production; central, low production; and back, high production. The English language consists of 15 vowels with the following production characteristics: two high front, two high back, two mid front, four mid central, two mid back, one low front, one low central, and one low back vowel (Singh & Singh, 2006). In comparison, English does not include the long vowels of /iː/, /aː/, and /uː/, while Arabic does not include /ə/, /e/, /ɛ/, /o/, /ʊ/, /ɑ/, /ɚ/, /ɝ/, /ɔ/, /ʌ/, /æ/, and /ɪ/ (Abushihab, 2010; Singh & Singh, 2006). In addition, both languages include diphthongs (Alotaibi & Meftah, 2013; Singh & Singh, 2006). Arabic utilizes two diphthongs, /a͡e/ and /a͡o/, which are not included in English; whereas, English utilizes 10 diphthongs, /a͡ɪ/, /a͡ʊ/, /e͡ɪ/, /o͡ʊ/, /ɔ͡ɪ/, /i͡ɚ/, /ɛ͡ɚ/, /u͡ɚ/, /o͡ɚ/, and /ɑ͡ɚ/, which are not utilized in Arabic (Alotaibi & Meftah, 2013; Singh & Singh, 2006).

Arabic and English exhibit additional differences in syllable structure and stress rules (Abushihab, 2010; Alotaibi & Meftah, 2013). Both English and Arabic contain open and closed syllables, such as consonant-vowel or consonant-vowel-consonant (i.e., CV or CVC) and consonant clusters (i.e., CC). Arabic rules restrict vowels from production in the initial position and requires them to be in the medial position of two consonants or in the final position; while English rules allow for production of vowels in syllable initial, medial, and final positions. Additionally, English vowels can stand alone as their own

syllable. With regard to clusters, Arabic limits the use of clusters to the medial and final positions, and to a maximum of two consonants; while English clusters occur in the initial, medial, and final positions with as many as three consonants initially and four consonants finally (Abushihab, 2010; Alotaibi & Meftah, 2013).

Phonetic development comparison. As shown in Figures 1 through 4 below, preliminary data on the consonant/ phonetic development in English and Arabic, at 8 and 12 months of age, reveals additional similarities and differences in the two languages (Alhaidary & Rvachew, 2010; Alhaidary, Rvachew, & Ja Nam, 2010). When investigating the manner of articulation, stops were exhibited more frequently than other phonemes across languages and ages. However, Arabic language learners exhibited more nasals at 8 months of age and more glides across ages, while English language learners produced more fricatives across ages. If focused on the place of articulation, coronals and labials were exhibited more frequently by both Arabic and English language learners. Specific comparison between the language groups revealed Arabic language learners produced significantly more coronals across ages and the English language learners utilized more glottals and dorsals at 8 months of age and more glottals and labials at 12 months of age (Alhaidary & Rvachew, 2010; Alhaidary, Rvachew, & Ja Nam, 2010).

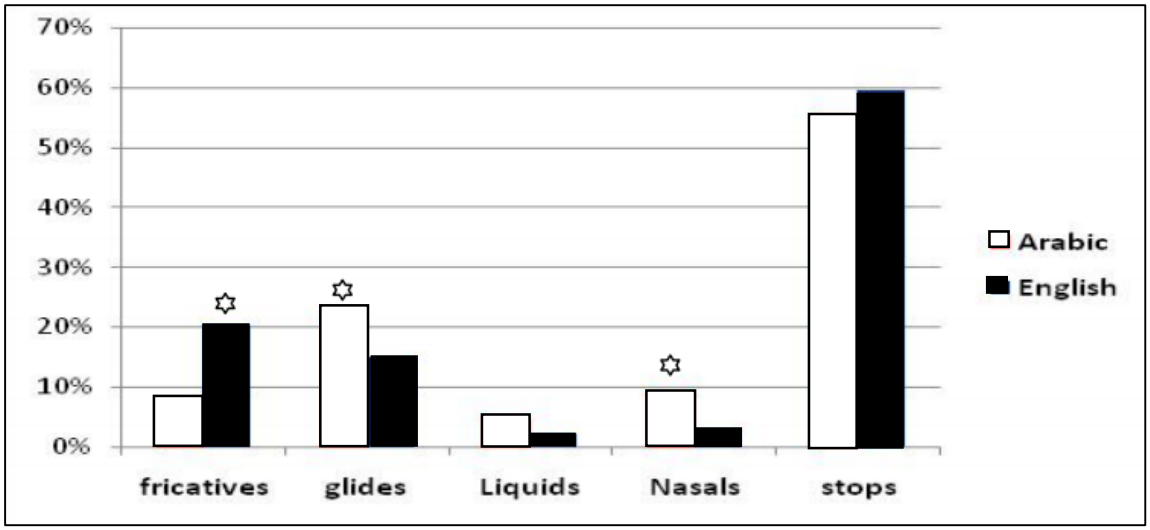

Figure 1. Proportion of each manner category by language group at 8 months of infant age (*indicates significant difference between groups) (Alhaidary & Rvachew, 2010).

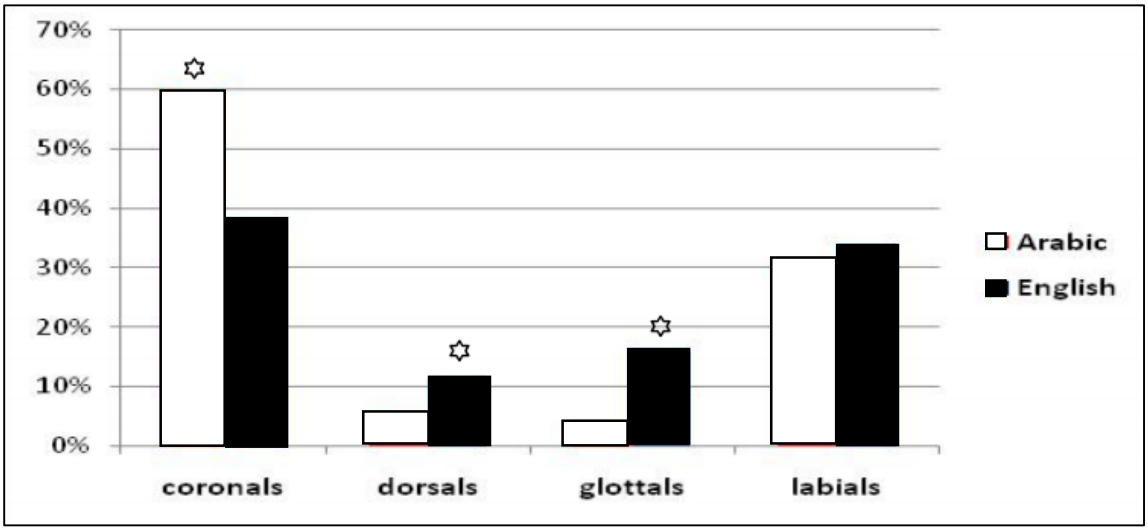

Figure 2. Proportion of each place category by language group at 8 months of infant age (*indicates significant difference between groups) (Alhaidary & Rvachew, 2010).

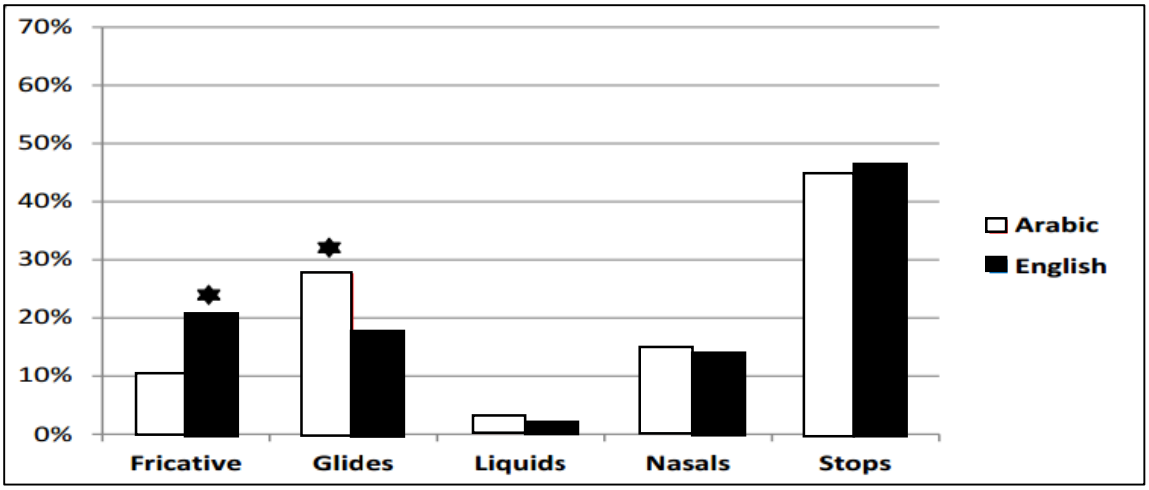

Figure 3. Proportion of each manner category by language group at 12 months of infant age (*indicates significant difference between groups) (Alhaidary, Rvachew, & Ja Nam, 2010).

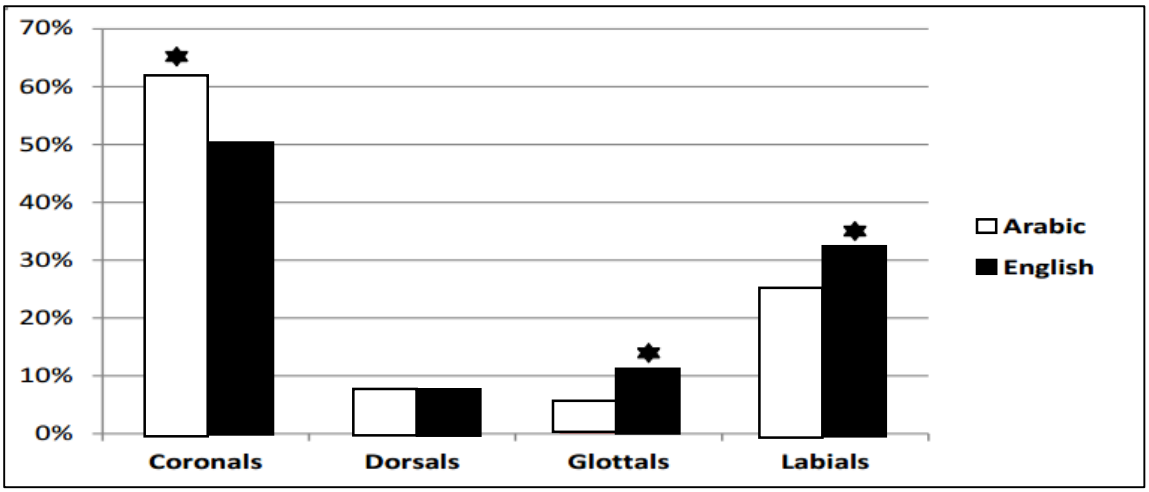

Figure 4. Proportion of each place category by language group at 12 months of infant age (*indicates significant difference between groups) (Alhaidary, Rvachew, & Ja Nam, 2010).

Bilingualism. Bilingualism is present when two languages are used by a speaker in his/her daily experiences (Baker, 2011; Paradis, 2007). When using the age of exposure as criterion, bilingualism can further be categorized as sequential or simultaneous. Paradis (2007) and Baker (2011) both indicated 3 years of age to be the critical period differentiating sequential and simultaneous bilingualism. Children who

begin learning two languages prior to 3 years of age are simultaneous bilinguals; whereas, children and/or adults learning a second language following establishment of a first language (after 3 years of age) are sequential bilinguals. For both simultaneous and sequential bilinguals, one language may be dominant to the other, or the two languages may be equally represented, with the speaker exhibiting equal levels of fluency in each language. The quality and amount of exposure to each language will impact whether or not there is a dominant language, which language is dominant, and phonetic development within each language (Hambly et al., 2013; Hoff et al., 2010; Werker, 2012).

Research Question

The current study focused on caregiver and naïve listener report of vocalizations produced by a bilingual language-learning infant versus an age- and gender- matched monolingual language-learning infant. The infants' vocalizations were analyzed from 6 to 17 months of age with vocalizations grouped into the following three age ranges: early (6 to 9 months of age - primarily prelinguistic vocalizations), middle (10 to 13 months of age - a combination of prelinguistic and early linguistic forms), and late (14 to 17 months - primarily first word productions) age groups. Specifically, the following question was posed: will caregiver and naïve listener report identify differences in vocalizations dependent upon language learning background at each age group? Moreover, through this study we completed an in depth analysis of the phonetic inventories reported by caregivers and naïve listeners to determine if the monolingual and bilingual inventories differed in consonant and vowel types and tokens. It was

hypothesized that caregiver and naïve listener report would similarly track vocal development in these infants indicating more glides, nasals, and coronals to be produced by the bilingual language learner in the early age group, and more fricatives, dorsals, and laryngeals to be produced by the monolingual language learner in the early age group. By the middle age group, slightly different inventories were expected given developing speech production mechanisms and greater influence from the ambient language environment. More glides and coronals were expected to be produced by the bilingual language learner and more fricatives, glottals, and labials were expected to be produced by the monolingual language learner.

Method

Participants

Participants included two infant/parent dyads selected from an archived data set gathered in a 14-month longitudinal vocal development study completed by the investigator's faculty mentor, Dr. Heather Ramsdell-Hudock. The original study was conducted at East Carolina University (ECU) and incorporated 16 infant/parent dyads. From 6 to 19 months of infant age, the infant/parent dyads participated in monthly audio and video recordings of infant/parent interaction to sample the infants' vocalizations for later analyses of vocal productions and comparison of phonetic transcription, caregiver report, and naïve listener report.

The bilingual infant was selected out of convenience based on significant exposure to two languages (Arabic and English) from birth. The monolingual infant was selected as an age- and gender-matched peer with exposure to one language (English) from birth. Both infants were males with no significant pregnancy or birth histories, from middle socioeconomic households including both a mother and father. The infants were matched on a variety of variables (e.g., age, gender, socioeconomic status, etc.) so as to increase the chance of differences in listener report resulting from language-learning background alone. The infants exhibited no risks for developmental delays and passed full audiologic evaluations of tympanometry, transient evoked otoacoustic emissions, and visual reinforcement audiometry at 6 and 18 months of age.

Procedures and Materials

Caregiver reports. Following previous approval from the Medical Center Institution Review Board at ECU, caregivers voluntarily gave informed consent for participation in the study. At the ECU Infant Vocal Developmental Laboratory, the caregivers completed weekly questionnaires, over the phone or at the monthly recording session, designed to gather the caregivers' observations of their infants' vocalizations. Specifically, the caregivers were asked "What sounds/words has your infant been producing since we last spoke?" (Ramsdell et al., 2012, p.10). For the purposes of this study, caregiver report from the two infants of interest was transcribed and tallied. Tallies were normalized according to the number of interviews obtained for each caregiver (differing numbers of interviews were obtained depending upon caregiver availability each week throughout the duration of the study).

Naïve listener reports. Prior to initiation of the study, exemption was obtained from the Human Subjects Committee at Idaho State University (ISU), as the study purpose was covered in the original consent. Two females, between the ages of 18 and 40, were selected as naïve listeners who were untrained in speech-language pathology, child development, or music (to avoid bias based on previously trained listening skills). Additionally, the listeners were native speakers of English with normal hearing and no children. The two participants volunteered to participate in the study in response to fliers posted on the ISU campus in Pocatello, ID and word of mouth. Informed consent was given voluntarily prior to participation.

The infant vocalizations from the archived data base were located based upon a breathe group criterion (Oller & Lynch, 1992) and extracted from the original recording sessions' audio file to eliminate extraneous caregiver and lab staff productions, toy sounds, and vegetative infant sounds. The extracted vocalizations were combined into one audio file for each recording session, such that there are 22 new audio files, one for each infant at each age from 6 through 17 months; although files for the bilingual infant at 9 and 17 months were not available. Depending upon infant volubility, the new audio files ranged in length from 3 to 7 minutes. The naïve listeners heard the new infant audio files with a one second separation between each utterance in randomized order via website presentation through an HTML5 and CSS (cascading style sheet) program developed specifically for this listening activity (see Figure 5). All audio files from one infant were presented in chronological order during a one hour session. A second one hour session followed in which the second infant's audio files were presented in chronological order. The naïve listeners was blinded to infant and infant age to prevent bias.

Following each recording, the naïve listeners responded to the question, "What kinds of sounds/words did the infant/baby produce?" These responses were recorded with a digital recorder and later transcribed by two transcribers, with a third transcriber coding 20% of the data to determine reliability across transcribers. The transcription results were tallied, in the same manner as caregiver report, to indicate the types and tokens of phonetic features in reported vocalizations. Tallies were normalized according

to number of sessions available for each infant (recall that 2 sessions were missing for the bilingual infant).

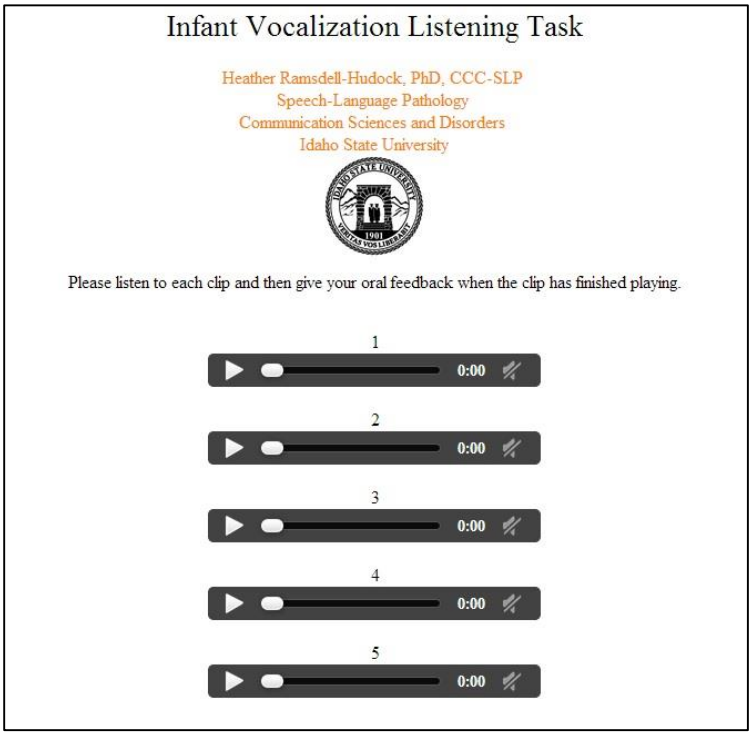

Figure 5. A sample image of the infant vocalization listening task.

Segmental and Suprasegmental Features

Following separate transcriptions for each caregivers' and naïve listeners' reports, descriptive statistics were compiled on tallied transcriptions for each infant at each age group of early (6 to 9 months), middle (10 to 13 months), and late (14 to 17 months). The total number of utterances, and total number of consonants and vowels in each reported utterance were calculated based on tallies for each listener (caregiver and naïve listener), each infant (monolingual and bilingual), and each infant age group (early, middle, and late age groups). In addition, reported consonant sounds were further organized according to place of articulation (number of labial, coronal, dorsal, and laryngeal consonants), manner of production (number of stop, fricative, affricate,

nasal, liquid, and glide consonants), and voicing (number of voiced and voiceless consonants). Reported vowel sounds were further organized according to tongue position (number of high front, low front, central, low back, high back, rising diphthong, and rhotic diphthong vowels).

Design

Variables of particular interest for this study included listener, language(s) of exposure, infant age group, and the number of different phonetic features reported. Descriptive statistics are presented to demonstrate patterns in data to answer the following question: will caregiver and naïve listener report identify differences in vocalizations dependent upon language-learning background at each age group?

Results

Employing caregiver and naïve listener report of infant vocalizations to explore differences in the phonetic inventories of a bilingual and monolingual infant allows us to determine the utility of these methodologies. Below, features for the selected infants are displayed in table from for both caregiver and naïve listener report. The tables demonstrate general features (e.g., number of utterances reported) and specific phonetic features (e.g., place of articulation and manner of production for consonants reported). Overall, caregiver and naïve listener reports indicated differences between the infants, with greater variability in manner of production for consonants and tongue position for vowels than for place of articulation and voicing for consonants. Caregivers reported more consistent patterns of development and clear differences between the infants. Naïve listener report indicated some areas of similarity with caregiver report. Further, both caregiver and naïve listener reports are consistent with several patterns of development based on previously published research.

Caregiver Report

Both caregivers in this study reported increases in general features (i.e. number of utterances, consonants, and vowels) across ages (Table 1); however, the bilingual infant reportedly increased the number of utterances, consonants, and vowels produced more with each age group than the monolingual infant. Further, in the early and middle age groups, the bilingual infant produced equal or similar tokens of utterances, consonants, and vowels; whereas, the monolingual infant reportedly produced equal tokens of utterances and vowels with six and seven fewer consonants in

the early and middle age groups, respectively. In the late age group, the bilingual infant produced tokens ranging from 98 to 144 in the following order from most to least: utterances, consonants, and vowels; however, the monolingual infant produced tokens ranging from 47 to 66 in the following order, most to least: consonants, vowels, and utterances.

Table 1
General features of caregiver report.

Infant	Infant Age (in Months)	# of Utterances	# of Consonant Tokens	# of Vowel Tokens
Bilingual	6 - 9	29	28	29
	10 - 13	56	54	59
	14-17	144	118	98
Monolingual	6 - 9	13	5	13
	10 - 13	35	29	35
	14-17	47	66	53

Caregiver report identified further similarities and differences between the two infants in regards to place of articulation (Table 2). For both infants, reports indicated increases in labial and coronal sounds across all age groups. The bilingual infant produced consistent increases in dorsals across age groups. Furthermore, in the early age group, both infants produced primarily labials. The bilingual infant produced the following places of articulation in decreasing order: dorsals, laryngeals, and coronals. In comparison, the monolingual infant reportedly produced equal tokens of coronals and laryngeals, while dorsals were not produced. By the middle age group, the bilingual infant produced primarily dorsals and similar tokens of labials and coronals; however, the monolingual infant produced similar tokens of coronals and dorsals, and fewer tokens of labials. Both infants produced laryngeals the least. In the late age group, the bilingual infant produced the most and equal tokens of labials and coronals, followed by

fewer dorsals. The monolingual infant, on the other hand, produced primarily coronals followed by similar numbers of labials and dorsals. Again, both infants produced laryngeals the least.

Table 2
Phonetic features of caregiver report.

Infant	Infant Age (in Months)	Place of Articulation for Consonant Tokens				Voicing for Consonant Tokens	
		Labial	Coronal	Dorsal	Laryngeal	Voiced	Voiceless
Bilingual	6 - 9	13	3	7	5	14	14
	10 - 13	14	15	20	5	35	19
	14-17	46	46	22	4	84	34
Monolingual	6 - 9	3	1	0	1	4	1
	10 - 13	5	12	10	2	19	10
	14-17	15	37	10	4	37	29

Both caregivers reported steady increases in voiced and voiceless consonants across age groups (Table 2). The bilingual infant report identified greater increases in voiced than voiceless consonants across the age groups; with the monolingual infant report indicating greater increases in voiced than voiceless consonants only from the early to middle age groups. From the middle to late age groups, the monolingual infant report revealed voiceless and voiced consonants to increase similarly. The bilingual infant produced equal tokens of voiced and voiceless consonants in the early age groups; whereas, in the middle and late age groups, he was reported to produce more voiced than voiceless consonants. In comparison, the monolingual infant reportedly produced more voiced than voiceless consonants across all age groups.

In regards to the manner of production, caregivers reported increases in stops, nasals, and glides across infants and age groups (Table 3). In addition, caregiver report indicated the monolingual infant to produce increasing numbers of fricatives and liquids

across age groups; while the bilingual decreased fricative production. Furthermore, the bilingual infant exhibited the greatest reported production of stops, and no affricates across age groups. In comparison, the monolingual infant reportedly produced the greatest number of stops in the middle and late age groups, with stop and nasal production being equal in the early age group. In the early age group, the bilingual infant produced a greater diversity in manner of production than the monolingual infant; whereas, the monolingual infant report indicated greater diversity in the middle and late age groups.

Table 3
Phonetic features of caregiver report.

Infant	Infant Age (in Months)	Manner of Production for Consonant Tokens					
		Stop	Fricative	Affricate	Nasal	Liquid	Glide
Bilingual	6 - 9	13	9	0	5	0	1
	10 - 13	33	8	0	8	0	5
	14-17	76	4	0	30	2	6
Monolingual	6 - 9	2	1	0	2	0	0
	10 - 13	15	3	1	5	2	3
	14-17	31	13	1	7	6	8

Across infants and age groups, caregiver reports indicated increases in the following vowels: high front, low front, high back, and rising diphthongs (Table 4). Additionally, the bilingual infant produced increasing numbers of central vowels across age groups; while the monolingual infant produced increasing numbers of rhotic diphthongs across age groups (despite being produced with the fewest tokens at the middle and late age groups). The bilingual infant reportedly produced no rhotic diphthongs in any age group.

Table 4
Phonetic features of caregiver report.

Infant	Infant Age (in Months)	Tongue Position for Vowel Tokens						
		High Front	Low Front	Central	Low Back	High Back	Rising Diphthong	Rhotic Diphthong
Bilingual	6 - 9	0	2	8	14	3	2	0
	10 - 13	7	3	13	21	7	8	0
	14-17	20	10	16	18	14	20	0
Monolingual	6 - 9	1	2	2	6	2	0	0
	10 - 13	2	7	8	6	3	8	1
	14-17	11	6	8	7	7	12	2

Naïve Listener Report

The naïve listeners in this study also reported similarities and differences between the productions of the bilingual and monolingual infant. Naïve listener reports indicated increases in the number of consonants across infants and age groups (Table 5). Further, the bilingual infant reportedly produced increasing numbers of vowels across age groups; while the monolingual infant's vowel tokens were reported to increase inconsistently. Overall, more utterances were reported to be produced in the late age group for each infant, with minimal changes occurring between the early and middle age groups.

Table 5
General features of naïve listener report.

Infant	Infant Age (in Months)	# of Utterances	# of Consonant Tokens	# of Vowel Tokens
Bilingual	6 - 9	17.7	15.0	17.0
	10 - 13	17.3	22.5	19.8
	14-17	29.7	47.7	41.3
Monolingual	6 - 9	23.3	22.5	28.0
	10 - 13	23.5	30.0	27.3
	14-17	30.5	45.8	37.8

When investigating place of articulation, the naïve listener report indicated an increase in coronals and a decrease in laryngeals for both infants across age groups

(Table 6). Additionally, across age groups, the bilingual infant produced an increasing number of labials and an inconsistently increasing number of dorsals. The monolingual produced an increasing number of dorsals and an inconsistently increasing number of labials. The bilingual infant primarily produced labials in the early and late age groups, and by the late age group, coronals were primarily produced. In comparison, the monolingual infant primarily produced labials in the early age group and coronals in the middle and late age groups.

Table 6

Phonetic features of naïve listener report.

Infant	Infant Age (in Months)	Place of Articulation for Consonant Tokens				Voicing for Consonant Tokens	
		Labial	Coronal	Dorsal	Laryngeal	Voiced	Voiceless
Bilingual	6 - 9	7.0	4.0	1.3	2.7	11.7	3.3
	10 - 13	11.3	4.8	5.3	1.3	19.3	3.3
	14-17	16.0	28.7	2.0	1.0	45.7	2.0
Monolingual	6 - 9	11.0	1.8	0.5	9.3	11.8	10.8
	10 - 13	8.3	12.8	5.5	3.5	17.3	12.8
	14-17	9.0	25.3	10.5	1.0	27.0	18.8

Furthermore, as shown in Table 6, naïve listeners reported increases across infants and age groups for voiced consonants. Report of the bilingual infant indicated equal tokens of voiceless consonants in the early and middle age groups, with a decrease in the late age group. Conversely, report of the monolingual infant indicated increasing numbers of voiceless consonant productions across age groups. Naïve listener reports indicated the bilingual infant to produce more voiced than voiceless consonants across age groups. Similarly, the monolingual infant produced more voiced than voiceless consonants across age groups, however, with a much smaller range than the bilingual infant.

Specific to the manner of production, naïve listener report indicated the monolingual and bilingual infant to produce an increasing number of stops across age groups (Table 7). Additionally, the monolingual infant was reported to produce an increasing number of affricates, liquids, and glides across age groups, while the bilingual infant reportedly produced no affricates or liquids, and only very few glides in the middle age group. Report of the bilingual infant indicated increases in nasals, and inconsistent increases in fricatives across age groups. In comparison, report of the monolingual infant indicated inconsistent increases in nasal productions and decreases in fricatives. Across age groups, the bilingual infant favored production of stops, followed by nasals, then fricatives. Similarly, the monolingual infant favored production of stops, followed by nasals in the middle and late age groups; however, in the early age group, the monolingual language learner was reported to favor nasals, fricatives, and then stops.

Table 7
Phonetic features of naïve listener report.

Infant	Infant Age (in Months)	Manner of Production for Consonant Tokens					
		Stop	Fricative	Affricate	Nasal	Liquid	Glide
Bilingual	6 - 9	6.7	2.3	0.0	6.0	0.0	0.0
	10 - 13	14.5	1.0	0.0	4.8	0.0	0.3
	14-17	32.0	1.0	0.0	14.0	0.0	0.0
Monolingual	6 - 9	4.8	7.5	0.0	9.3	0.5	0.5
	10 - 13	13.8	5.3	0.5	7.3	1.3	2.0
	14-17	21.3	3.3	3.8	7.5	6.0	4.0

Naive listener report indicated no similar trends in vowel production between infants across age groups (Table 8). For example, the bilingual infant reportedly produced increasing tokens of low back and high back vowels across age groups, while the monolingual infant reportedly produced increasing tokens of rising and rhotic

diphthongs across age groups. Furthermore, the bilingual infant produced primarily central, then low front vowels in the early age group; low front, then central vowels in the middle age group; and high back, then high front vowels in the late age group. In comparison, the monolingual infant produced primarily low front, then central vowels in the early and middle age groups; and primarily rising diphthongs, then central vowels in the late age group. Additionally, the bilingual infant was reported to produce no rhotic diphthongs.

Table 8

Phonetic features of naïve listener report.

Infant	Infant Age (in Months)	Tongue Position for Vowel Tokens						
		High Front	Low Front	Central	Low Back	High Back	Rising Diphthong	Rhotic Diphthong
Bilingual	6 - 9	2.0	4.3	5.7	1.7	0.0	3.3	0.0
	10 - 13	0.8	6.8	5.8	3.5	2.3	0.8	0.0
	14-17	7.3	6.3	6.7	5.0	14.0	2.0	0.0
Monolingual	6 - 9	3.8	8.8	6.3	4.8	3.5	1.0	0.0
	10 - 13	3.3	7.5	5.5	3.0	3.0	4.5	0.5
	14-17	5.5	5.3	9.5	3.3	2.0	11.3	1.0

The data from Tables 5 through 8 are collapsed across the two naïve listeners and two transcribers. Reliability between the two transcribers was assessed by a third coder who transcribed 20% of the naïve listener report, specifically, four randomly selected sessions, two from each infant. The three transcribers transcribed the naive listener report exactly the same 77% of the time on 96 comparisons (four sessions multiplied by 24 features compared across transcribers). For noted differences, one transcriber differed by one tally from the other two transcribers 13% of the time. For example, one transcriber noted only one liquid consonant in one of the four session, while the other two transcribers noted two liquid consonants in that same session.

Differences between transcribers exceeded one feature in only 10% of the compared sessions.

Caregiver and Naïve Listener Report Comparison

Caregivers and naïve listeners completed the same task in reporting what sounds/ words they heard the infants produce, although the circumstances of these tasks differed greatly. Caregivers reported on productions heard during hours of daily interactions with their infants in a natural environment and knowledge of ambient language(s); whereas, naïve listeners reported on a much smaller sampling of productions gathered from recordings in a laboratory setting and were blinded to the number of infants, infants' age, language background, and context of vocalizations. Due to the limited sample size and different reporter circumstances in the present study, descriptive statistics were utilized to compare caregiver and naïve listener report, instead of statistical analyses.

When comparing reports of general features (Tables 1 and 5), caregiver and naïve listener reports similarly tracked the increases across age groups in utterances produced by the monolingual infant. Although for the bilingual infant, caregiver report indicated consistent increases in utterance tokens across ages, the naïve listener report indicated inconsistent increase from the early to middle age group. Overall, the caregiver report identified more utterances across all age groups for the bilingual infant. In comparison, for the monolingual infant, the naïve listener reported more utterances in the early age group. Further, caregiver and naïve listener reports similarly tracked the increases across age groups in consonants produced by both infants. Across all age

groups, caregivers reported more consonants than naïve listeners for the bilingual infant. Conversely, the caregivers reported fewer consonants in the early age group, similar tokens in the middle age group, and more tokens in the late age group for the monolingual infant

For place of articulation, caregivers and naïve listeners reported both infants to produce increasing numbers of coronal sounds across age groups, primarily produce labials in the early age group, and produce the fewest laryngeal tokens in the middle and late age groups (Tables 2 and 6). Further, both listeners indicated the monolingual infant to produce primarily coronals followed by similar numbers of labials and dorsals in the middle and late age groups. Moreover, caregivers and naïve listeners reported steady increases across age groups in tokens of voiced consonants for both infants, and voiceless consonants for the monolingual infant. Additionally, both listeners indicated voiced consonants to increase more than voiceless consonants across infants and age groups.

For manner of articulation, caregivers and naïve listeners reported that both infants increased productions of stops, and the monolingual infant increased productions of liquids and glides across age groups (Tables 3 and 7). Furthermore, both listeners indicated that the bilingual infant primarily produced stops, and produced no affricates. Conversely, caregivers reported increases in tokens of glides for the bilingual infant across age groups; while, naïve listeners reported only minimal glides produced by the bilingual infant in the middle age group. Caregivers and naïve listeners similarly indicated the monolingual infant to produce primarily stops in the middle and late age

groups. However, in the early age group, caregivers reported the monolingual infant to produce nasals and stops with equal majority, and the naïve listener indicated only nasals as primary productions. Further, caregiver report indicated a steady increase in fricatives for the monolingual infant across age groups, while the naïve listener report indicated a steady decrease in production of fricatives.

As demonstrated in Tables 1 and 5, caregiver report identified more tokens of vowels across age groups for the bilingual infant than naïve listener report. In comparison, caregiver report indicated fewer tokens of vowels for the monolingual infant in the early age group but more tokens in the middle and late age groups. Caregivers reported a steady increase in vowels across age groups for the monolingual infant, while naïve listener report indicated inconsistent increases from the early to late age groups. Listeners similarly tracked steady increases across age groups in tokens produced by the bilingual infant. Furthermore, caregiver and naïve listener reports similarly indicated increases in central and high back vowels for the bilingual infant (Tables 4 and 8). Additionally, neither listener reported the bilingual infant to produce rhotic diphthongs at any age. Listeners similarly indicated rising and rhotic diphthongs to increase across age groups for the monolingual infant. For both infants, caregiver report identified four types of vowels increasing across age groups; however, naïve listeners reported none.

Discussion

In review, three factors (among others) hinder researchers and clinicians from utilizing infant vocal development to inform about later speech and language ability: the cumbersome nature of phonetic transcription, the variability within typical monolingual development, and the contradictions involving typical bilingual developmental patterns and norms (Fabiano-Smith & Goldstein, 2010; Hambly et al., 2013; Heimann et al., 2006; Hoff et al., 2012; Lieven & Stoll, 2013; Mattock et al., 2010; Oller et al., 1997; Ramsdell et al., 2012; Watt et al., 2006; Wetherby et al., 2002; Wetherby et al., 2003). As traditional transcription methodology typically results in over-representative phonetic inventories, more recent research has begun to explore caregiver report as a more valid means of tracking infant vocal development. Furthermore, naïve listener report has been suggested as a laboratory method to simulate caregiver report (Ramsdell et al., 2012).

The purpose of the present study was to investigate similarities and differences between caregiver and naïve listener report of vocalizations produced by a bilingual Arabic-English language learner and an age- and gender- matcher monolingual English language learner. It was hypothesized that the caregiver and naïve listener reports would similarly track vocal development in these infants across age, with types of sound differences corresponding to ambient language background between the monolingual and bilingual language learner. The new methodologies utilized in this case study were able to identify similarities and differences in the vocal development of the two infants. Both caregiver and naïve listener reports suggest appropriate vocal development, with

differences noted in phonemic inventories. Overall, caregiver report indicated more tokens of sounds produced by the bilingual infant; however, naïve listener report varied between infants and ages.

The results of this study indicate the need for continued research to explore the utility of caregiver and naïve listener reports in relation to prelinguistic vocalizations. These new methodologies may lead to a more readily available means of determining an infant's development in comparison to phonetic transcription, which could facilitate establishment of speech sound development norms at younger ages for monolingual and bilingual language learners, and earlier identification of delays appropriate to the infant's native language(s). Thus, the ease with which caregiver and naïve listener report can be implemented may facilitate translation from basic research to clinical practice.

Caregiver Report

Without training or copious amounts of time gathering data, caregiver report emulates several basic patterns of speech development that we would anticipate (e.g., consonants increasing at a faster rate across age groups than vowels, more voiced consonants than voiceless consonants across development, etc). Caregiver report supports the hypothesis that the bilingual infant would produce more coronals than the monolingual infant in the early and middle age groups, and that the bilingual infant would produce more glides and nasals in the early age group, and more glides in the middle age group than the monolingual infant. Conversely, the reports failed to support the hypothesis that the monolingual infant would produce more laryngeals and dorsals in the early age group and more laryngeals and labials in the middle age group than the

bilingual infant. Reports also failed to indicate that the monolingual infant produced more fricatives than the bilingual infant in the early and middle age groups. Given that some aspects of the hypothesis were upheld, caregiver report may be a valuable method of tracking infant vocal development, and more valid than phonetic transcription.

In accordance with current knowledge, caregiver report indicates more tokens of vowels than consonants in the early and middle age groups, and more tokens of consonants than vowels by the late age group (Chen & Irwin, 1948). Furthermore, in alignment with Alhaidary and colleagues (2010), Alhaidary and Rvachew (2010), and Irwin (1947b), caregivers reported labials as most frequently produced in the early age group by both infants. Caregiver report for the monolingual infant in the early age group identified dorsals as the least frequently produced; however, the bilingual infant report contradicted norms by indicating that coronals were produced least (Alhaidary & Rvachew, 2010; Irwin, 1947b). In the middle age group, caregiver reports further align with previous research (Alhaidary et al., 2010; Irwin, 1947b), indicating laryngeals to be the least produced across infants, coronals to be the most produced by the monolingual infant, and coronals to be the second most frequently produced by the bilingual infant. In contradiction to current knowledge (Alhaidary et al., 2010; Irwin, 1947b), the bilingual infant report indicates dorsals as most frequently produced place of articulation. By the late age group, caregiver report aligns perfectly with previous research, identifying coronals and labials as most frequently produced, while dorsals and laryngeals occur less often for both infants (Irwin, 1947b).

Additionally, across age groups and infants, caregiver report indicated that stops were primarily produced followed by fricatives and nasals, which aligns with research on monolingual English infants (Alhaidary et al., 2010; Alhaidary & Rvachew, 2010; Irwin, 1947a). According to research on monolingual Arabic infants, glides would be occurring more frequently than fricatives (Alhaidary et al., 2010; Alhaidary & Rvachew, 2010). Furthermore, across infants and ages, caregivers reported liquids and affricates to be least commonly produced, as would be expected for both monolingual English and Arabic infants (Alhaidary et al., 2010; Alhaidary & Rvachew, 2010; Irwin, 1947a).

Caregiver report of vowels indicated further similarities and differences between inventories in comparison to previous research findings (Irwin, 1948). For the bilingual infant, caregivers reported the infant to produce primarily back vowels across age groups; however front vowels are expected to be primarily produced across age groups. In the early and middle age groups, central vowels followed back vowels and front vowels were produced least. In the early age group, central vowels are expected to be the second most commonly produced, and in the middle age group, central vowels are expected to be the least commonly produced. In the late age group, caregiver report is consistent with current knowledge, indicating central vowels were produced least often. For the monolingual infant, caregiver report differed slightly from previous research in the early and middle age groups, suggesting front vowels were the most common, or at least the most reported for these two infants. In the early age group, the infants were reported to primarily produce back vowels, and produce central vowels the least. In the middle age group, front and back vowels were produced equally followed by central

vowels. Caregiver report in the late age group met expectations that front vowels would be produced primarily, followed by back vowels, and central vowels being least common.

Overall, caregiver report indicated differences in vocal development between these infants, despite not fully supporting the hypothesis in relation to specific differences in manner and place of articulation based on infant language(s) of exposure. Lack of support for the hypothesis may be the result of basing the hypothesis on research of monolingual English and Arabic infants, while the current study focused on a bilingual Arabic- English infant who would be expected to develop slightly different than monolingual peers. Accordingly, differences observed between previous research and caregiver report for the bilingual infant may be the result of comparing to data on monolingual Arabic development. Even though differences were observed, caregiver reports were consistent with overall trends of infant vocal development based on current knowledge and warrants additional research.

Naïve Listener Report

The current study utilized naïve listeners in an attempt to simulate caregiver report and continue validation of these new methodologies in tracking infant vocal development. Naïve listener report supports the hypothesis that the bilingual infant would produce more coronals than the monolingual infant in the early age group, but not in the middle age group. Additionally, report supports the hypothesis that the monolingual would produce more laryngeals in the early and middle age groups, but not more dorsals in the early age group and more labials in the middle age group. Further,

naïve listener report is consistent with part of the hypothesis that the monolingual infant would produce more fricatives in the early and middle age groups than the bilingual infant. Reports failed to indicate that the bilingual infant produced more glides and nasals in the early age group, or more glides in the middle age group. Given these results, along with the fact that only one published study has explored the utility of naïve listener report (Ramsdell et al., 2012), further research is necessary to clarify the utility of this methodology in tracking vocal development in a more functional way than traditional methodology.

Beyond the hypotheses, naïve listener report indicated some features of expected developmental patterns. For both infants, naïve listeners reported vowels to be produced more than consonants in the early age group, and consonants produced more than vowels by the late age group, which is consistent with previous research (Chan & Irwin, 1946). Also as expected, naïve listeners reported labials and coronals as the most commonly produced places of articulation for consonants, and laryngeals and dorsals as the least commonly produced across infants and age groups (Alhaidary et al., 2010; Alhaidary & Rvachew, 2010; Irwin, 1947b). Differences were observed in naïve listener report for the second and third most frequently produced places of articulation across infant and age groups.

As expected, naïve listeners reported primarily productions of stops for both infants across age groups, except for the monolingual infant at the early age group, where nasals were reported most often. Furthermore, nasals were reported second most often for the bilingual infant across age groups, and for the monolingual infant in

the middle and late age groups. For the bilingual infant, fricatives were the third most often produced. This is contradictory to Irwin (1947a) who found fricatives to occur more often than nasals. However, according to Alhaidary and colleagues (2010) as well as Alhaidary and Rvachew (2010), English data indicate fricatives and glides to follow stop production in frequency for the early and middle age groups, while Arabic data suggests glides and nasals to follow stop production in frequency. Furthermore, based on Irwin (1947a), naïve listener report accurately identifies nasals and fricatives as being produced more often than liquids, glides, and affricates in the early and middle age groups by the monolingual infant. Conversely, Alhaidary and colleagues (2010) and Alhaidary and Rvachew (2010) indicate glides are expected to occur more often than nasals, liquids, and affricates in the early and middle age groups. Moreover, naïve listener report is mostly consistent with current knowledge that liquids and affricates are produced least across infants and age groups, with the exception of the monolingual infant in the late age group when liquids were third most frequently produced and fricatives were produced the least (Alhaiday et al., 2010; Alhaidary & Rvachew, 2010; Irwin, 1947a).

Naïve listener report of the monolingual infant across age groups also indicated front vowels as primarily produced, as would be expected (Irwin, 1948). In the early age group for the monolingual infant, naïve listener report indicated back vowels as more frequent than central vowels, which is more consistent with expectations for the middle age group. Naïve listener report continues to be consistent with middle age group expectations for the monolingual infant by reporting back vowels as being produced

more often than central vowels. By the late age group, however, report indicated central vowels to be produced more than back vowels by the monolingual infant, which differs from current knowledge. Greater differences between naïve listener report and previous research were observed in regards to the bilingual infant. Naïve listener report was only as expected with respect to back vowels being least common in the early age group, front vowels being primarily produced in the middle age group, and central vowels being produced least in the late age group. Furthermore, in the middle age group, the bilingual infant produced back vowels second in order of frequency; however, the infant reportedly produced central vowels equally to back vowels.

Bilingual Infant versus Monolingual Infant Vocalizations

Based on the results and analysis of both listeners, slight differences between the infants were reported, especially in the quantity of sounds across age groups (e.g., the monolingual language learner was generally reported to produce fewer sounds than the bilingual language learner). The data further revealed differences between caregiver report and naïve listener report. Both caregivers and naïve listeners reported general phonetic development similar to what would be expected (e.g., more vowel productions in the early age group, and more consonant productions in the late age group). Listeners also indicated that the infants displayed a general increase in phonetic features across age. Despite minimal differences, no delay was indicated for either infant across age groups. It is interesting, however, to note that the infant who was a bilingual language learner generally produced very similar quantities of most phonetic

features according to listeners with more generally more reported by the caregiver. This difference in the quantity of sounds reported was not hypothesized.

Potential Limitations

Several limitations to the study have been identified as factors leading to potential differences between caregiver and naïve listener report and utility of results. One limitation stems from caregiver and naïve listener reports being based on different samples of the infants' vocalizations. Caregivers reported on vocalizations heard throughout daily interactions with their infants in a natural environment. Thus, caregivers were exposed to a greater volume of vocalizations. Additionally, caregivers are involved in the development of their infants' speech and language by reinforcing sounds that their infants produce (Ramsdell et al., in review). With this involvement, caregivers are likely to report sounds they reinforce and sounds that are more word-like, repeated more often, and more salient to them. Moreover, Caregivers made reports at monthly recording sessions when questioned by laboratory staff. On occasion, caregivers were prompted to clarify the way their infant produced a word. For example, if a caregiver reported her infant to say 'green,' a laboratory staff member asked, "how does he say green?" or "does it sound like green?"

In comparison, naïve listeners reported on sounds extracted from one, 20 minute recording. The naïve listeners were not privy to the context or social interactions the infants were involved in when producing the vocalizations. While audio files were played for one infant at a time, from early to late age groups, listeners did not know how many infants, or the ages of the infants they were listening to. Files were

played one after the other with time in between each to answer the questions, “What sounds or words did the infant/ baby produce?” Naïve listeners reported that the vocalizations began to sound the same, and that they might be reporting sounds from a different audio file due to the blurring of sounds. Furthermore, one naïve listener questioned whether she was to report what word the infant was attempting to say or how the infant said the word. The primary investigator repeated the questions without prompting her one way or the other. This is quite different from the prompting caregivers received.

Another limitation arises from the bilingual infant’s caregiver and naïve listeners having different language backgrounds. Based on Best and Tyler (2007), personal developmental history, as well as linguistic experience influences each listener’s perception of phonetic information. Thus, the bilingual infant’s caregiver’s perceptual abilities of English and Arabic presumably differs from the monolingual English naïve listener’s perceptual abilities, and may have resulted in less accurate simulation of the caregiver report. For example, the caregiver and naïve listener may have reported different sounds when listening to the same infant vocalization given different perceptual abilities.

Furthermore, the similarities of the naïve listener and caregiver report in this study do not directly support results found by Ramsdell and colleagues (2012). Although naïve listener methodology used in the current study was based on the Ramsdell and colleagues’ naturalistic listener procedure, the listeners used by each study met different qualifications. The naïve listeners of this study were not studying,

and had not studied in the fields of speech-language pathology, music, or child development; however, the naturalistic listeners were laboratory staff working on coding infant vocalizations as part of a project focused on infant vocalizations and/ or early speech development (Ramsdell et al., 2012). Although specific training for the listening task was not given to the laboratory staff in the prior study, their experience in coding infant vocalization could qualify them as trained listeners in comparison to the naïve listeners of the present study.

As the current study does not compare the new methodologies to traditional phonetic transcription, another limitation is evident. In order to truly determine the validity, the caregiver and naïve listener reports for the two infants in this study must be compared to transcription of the infant vocalizations. Previous research suggests that if a comparison to transcription was included, transcription would result in phonemic repertoires that are much larger, and over-representative of the infants' abilities than caregiver and naïve listener report (Ramsdell et al., 2012).

Lastly, the small sample size of the current study limits the ability to generalize the results to larger populations. Thus the phonemic inventories and patterns of development for both the English monolingual infant and the Arabic-English bilingual infant are not sufficient evidence to support utilizing them in clinical practice. Expanding the sample size beyond two infants would increase the reliability and validity of results.

Clinical Implications

Based on the results of this study, caregiver and/ or naïve listener reports may be a more valid means of tracking infant vocal development than phonetic transcription. With increased participants in future research and further support of the validity of these new methods, traditional methodology may be replaced. Moreover, these new methods will potentially link research to clinical practice by offering critical information about developmental patterns in the monolingual and bilingual populations. If caregiver report were found to better track infant vocal development, for example, clinicians could easily ask caregivers about prelinguistic vocal development and receive responses that could inform practice. As it stands, it is difficult to utilize prelinguistic developmental staging to inform practice for many reasons, among which we could include the cumbersome nature of phonetic transcription. If these methods can be utilized to establish development norms and/or at risk behaviors, clinician may be able to identify infants with, or at risk of speech and language delays/disorders based on caregiver report and/or clinical observations.

Future Research

Based on the potential limitations and clinical implications of the current study, future research should include a larger sample size, comparison of caregiver and naïve listener report to traditional phonetic transcription, and further development of the naïve listener methodology. An increased sample size would lead to more reliable and valid results that may be applicable to a larger population. For example, a larger sample size may answer the following questions: do vocalizations produced by infants begin to

align with the phonetic characteristics of the ambient language? Furthermore, comparing caregiver and naïve listener report to phonetic transcription is expected to support that these new methods result in more representative inventories in a less tedious and more functional manner than the traditional approach.

Lastly, further development of the naïve listener methodology could explore a few areas. Research should include comparison of the naturalistic listener (i.e. laboratory staff) from Ramsdell and colleagues (2012) and the naïve listener (i.e. untrained listener) of the current study. As the naturalistic listener could be considered a trained listener, future research should compare naturalistic and naïve listener report to caregiver report to determine which listener simulates caregiver report more accurately. Additionally, as naïve listeners of the current study had no children, research should explore the ability of naïve listeners to simulate caregivers more closely if they have children.

Overall, the results and clinical implications of this study warrant further investigation of this topic. The potential to translate this research into accessible means for speech-language pathologist and pediatricians creates a need to continue to investigate these methodologies.

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