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Classification of Infant Vocalizations by Untrained Listeners: Part 2

by

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Committee Approval

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Dedication

This thesis is dedicated to John “Jack” Brown. Thank you for being such a huge part of my life. You’re my inspiration! Without you, I would not be where I am today, nor would I have smiled so much along the way. I love you, Jackeet!

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Classification of Infant Vocalizations by Untrained Listeners

Thesis Abstract – Idaho State University (2018)

The purpose of the present study was to aid in the development of a “gold standard” for classification of infant vocalizations. Obtaining such “gold standard” would enable clinicians and caregivers to better communicate and enhance accurate interpretation of parent report. Twenty-four untrained listeners (with no unique perspective on auditory perception) were presented with auditory stimuli of infant vocalizations and a previously generated list of terms. The listeners were asked to select terms from the list that they thought best described the sounds presented. Classifications of infant vocalizations by untrained listeners overlapped with classifications used in clinical and research settings by professionals and provided additional insight into alternate terms used by caregivers to describe baby sounds. Developing a gold standard for describing infant sounds can improve communication between speech-language pathologists and families, which could increase the specificity and sensitivity of infant assessment. Study limitations and future directions will be discussed.

Key words: infant assessment, speech-sound development, infant language, early language development, early intervention

Classification of Infant Vocalizations by Untrained Listeners

Children that are identified as having disorders in the first 3 years of life are likely to face substantial difficulty throughout all aspects of life (e.g., including academic, employment, social, and psychological wellbeing). Work toward reducing the effect of these potential life-long deficits can begin if a child is identified as early as possible and placed in early intervention services (Hebbeler, Spiker, Bailey, Scarborough, Mallik, Simeonsson, & Singer, 2007; American Speech-Language-Hearing Association [ASHA], 2007; National Institute of Child Health and Human Development [NICHD], 2002). Due to the heavy reliance on parent report during assessment of infant speech-language skills, it is necessary to determine if parents and caregivers¹ classify infant vocalizations in the same manner as professionals. Past research shows that caregiver ability to report on infant development is often a natural skill they possess, resulting in report that accurately represents their infant's true abilities (Feldman et al., 2005; Heilmann, Ellis Weismer, Evans, & Hollar, 2005; Oller, Eilers, & Bassinger, 2001). However, a challenge presents itself in bridging the gap between how trained professionals (e.g., speech-language pathologists or SLPs) and untrained² caregivers classify infant sounds. In order to overcome this challenge, we need to determine the consistency between these reports, and identify a “gold standard” for terminology (the *best* terms). Perry, Ramsdell-Hudock, and Warlaumont (2015) conducted a study, which set the foundation for the present work; they found that the classifications of infant vocalizations generated by untrained individuals (caregivers)

¹ From this point on, the term *caregiver* will be used to refer to both parents and any individual who provides primary caretaking for an infant.

² “Listeners qualified as untrained if they had not been previously educated in linguistics, protophones terminology, speech-language pathology, child development, or music (to avoid bias based on previously trained listening skills)” (Perry, 2016, p. 17).

showed some overlap with how these vocalizations are classified by researchers in the laboratory setting. Further clarifying specific terms that untrained individuals use to name prelinguistic vocalizations will make the assessment process more specific and sensitive overall, enabling more efficient identification of children who would benefit from early intervention services.

The *long-term goal* of this research is to develop a list of gold standard terms for classification of infant vocalizations. Obtaining gold standard terminology will enable clinicians and caregivers to better communicate and enhance accurate interpretation of parent report. In turn, accurate interpretation may facilitate earlier identification of infants at risk for speech and/or language delay/disorder. Through the present study, we looked to narrow down the list of terms caregivers use to describe infant vocalizations. The *question* was, “how do caregivers classify infant vocalizations across age ranges when provided a pre-generated list of descriptive terms to choose from?” The *rationale* for this line of study was that, determination of specific terminology for discussion of prelinguistic productions will improve caregiver and clinician/researcher communication, and facilitate early intervention through more efficient means of identifying atypical patterns earlier in age.

The *central hypothesis* for this project was tested by pursuing the following *aim*: from 4 to 12 months of infant age, across typically developing infants, we identified the preferred terms used by caregivers in discussion of prelinguistic vocalizations when provided a list of descriptive terms to choose from. Based on prior documentation that caregiver report is reliable for describing infant vocalizations, the *working hypothesis* for this aim was that sound types reported would fall into several distinct categories that could be used to describe infant vocal development in the future. We expected the outcome for the aim to show that untrained listener descriptions would yield some overlapping, and some alternate/additional terminology to provide more

complete coverage of the range of sounds infants produce, as well as make training of coding infant vocalizations more natural. This research will provide a list of gold standard terminology for how to refer to infant vocalizations. The results could have an important *positive impact* on clinicians, researchers, caregivers, and clients by moving us one step closer to streamlining the process of identifying developmental status for early identification of speech and/or language delay/disorder, and early intervention.

Assessment of Infant Vocalizations

Previous research demonstrates that infant vocal skill are a predictor of later language deficits: “The findings demonstrate continuity between prelinguistic and linguistic skills and how individual differences in a number of prelinguistic skills contribute collectively and uniquely to language outcome” (Watt, Wetherby, & Shumway, 2006, p. 1224). For example, Stoel-Gammon (1989) found that infants who were delayed, particularly within the canonical babbling stage, are at a substantially higher risk for later disorders. These findings emphasize the importance of accurate, reliable assessment measures. There are several methods available to assess infant vocal development. According to Nathani, Ertmer, and Stark (2006), the following are available tools used to assess infant vocal development: the Bayley Scales of Infant Development-II (BSID-II), the Communication and Symbolic Behavior Scales (CSBS), the Early Language Milestones Scale (ELMS), the Infant-Toddler-Meaningful Auditory Integration Scale (IT-MAIS), the Rosetti Infant-Toddler Language Scale, and the Preschool Language Scale-4 (PLS-4). These measures involve observation, parent report, or a combination of the two.

Ramsdell, Oller, Buder, Ethington, and Chorna (2012) discuss that the most effective way to collect a comprehensive picture of a prelinguistic infant’s vocal abilities is to rely on parent report. Communicative Development Inventories (CDIs) are reports provided by parents

regarding their young child's early communicative skills (Law & Roy, 2008). The CDIs can be collected face-to-face or over the telephone (Oller, Eilers, & Basinger, 2001; Law & Roy, 2008). Some advantages of collecting parent report are that parents provide SLPs with a comprehensive view of the child's vocal skills in a naturalistic setting, and the inventories are easy to administer (Law & Roy, 2008). Reliance on parent interview may also reduce the risk for noncompliance (Chiat & Roy, 2007). Speech-language pathologists must be cautious while interpreting the results of parent reports, because previous research has also shown that the level of education parents have received may influence the accuracy of their report (Law & Roy, 2008). Also, parents may over or under estimate their child's ability, thus altering the reliability of this form of assessment (Law & Roy, 2008).

While previous research has shown that trained and untrained individuals may classify and react differently to infant speech sounds (Munson, Johnson, & Edwards, 2012), it has also been found that caregivers are surprisingly intuitive when it comes to recognizing and describing the sounds that their infants produce (Oller et al., 2001). However, there is potential for discrepancies to exist between trained and untrained listeners in interpretation of infant ability due to different levels of experience and education between the groups (Munson et al., 2012). This poses difficulty in the assessment process since parent report is such a large portion of the screening process, and could hinder the ability of the SLP to identify children at-risk for language deficits (Oller et al., 2001; Stoel-Gammon, 1989). Overall, caregivers have provided "versatile, efficient and valid measures of language development in young children both with and without developmental disabilities, and [their reports] have been used effectively in both clinical and research settings" (Law & Roy, 2008, p. 203).

Professional Classification of Infant Sounds

During assessment of infant vocal development, SLPs and other trained professionals classify infant sounds in a variety of ways. One classification scheme was provided by Bates, Camaioni, and Volterra (1975), who describe prelinguistic development of vocalizations in terms of performatives. Performatives include perlocutionary, illocutionary, and locutionary acts. Perlocutionary acts are vocalizations that serve a subconscious purpose that the infant does not have any control over, including reflexive sounds (cries, burps, and sneezes). “Perlocutionary infants may rarely use communicative gestures (e.g., pointing) but may perform non-communicative behaviors, such as throwing, pushing, and banging a frustrating toy perhaps, as a primitive instrumental means for making the toy work” (Harding & Golinkoff, 1979, p. 34). Illocutionary acts involve a child or infant using non-verbal communication systems to intentionally convey a message. For example, a child pointing to a bottle to indicate that he/she wants more. According to Harding and Golinkoff (1979), infants in the illocutionary stage make more contact with their communication partner and direct attention to objects or themselves. Finally, locutionary acts involve both intention and verbal output of speech. Harding and Golinkoff (1979) state that children do not typically begin using vocalizations intentionally until they reach 10 months of age.

Infant vocalizations can also be described as either word-like or babbling; infant sounds are word-like if they mimic those of real words, and babbling if they could never be interpreted as sounding word-like (Yeni-Komishian, Kavanagh, & Ferguson, 1980). This classification scheme is derived from a stage model of development, as presented by Oller (2000). Yeni-Komishian, Kavanagh, and Ferguson (1980) describe some of the first developing infant sound productions as “reflexive,” meaning that they tell the listener something about the physical state

of the child, but do not convey intentional meaning, and include involuntary cries, coughs, and hiccups. This would correspond with the first stage of vocal development, the phonation stage, which typically takes place from 0 to 1 month. Yeni-Komishian and colleagues (1980) state that observing speech-like sounds during this stage of development is rare. The phonation stage involves the previously mentioned reflexive sounds (coughs, hiccups, sneezes, etc), and also some non-reflexive, quasi-resonant nuclei. Quasi-resonant nuclei are described as typical phonation without distinct contrast between opening and closing of the vocal tract (Yeni-Komishian et al., 1980). Along with quasi-resonant nuclei, some fully resonant nuclei are seen in infants' first 2 months of development. Fully resonant nuclei are typically referred to as vowels or coos by professionals (Yeni-Komishian, 1980). While there is some variation within the way and order infants begin using each of these sounds, professionals group these stages of development differently. The American Speech-Language Hearing Association (ASHA; 2017) describes the “talking” stage from 0 to 3 months of age as consisting of pleasure sounds, crying to get needs met, and smiling in response to the presence of a familiar caregiver.

According to Yeni-Komishian and colleagues (1980) the goo stage, which takes place between 2 and 3 months, involves the infant having some control over their vocalizations. Quasi-resonant nuclei become repetitive, and fully-resonant nuclei are combined with consonant-like sound closures (Yeni-Komishian et al., 1980).

The expansion stage takes place between 4 and 6 months of age (Yeni-Komishian et al., 1980). Here, vocalizations become more consistent, and can be described as “vocal play” or “exploration”. Fully resonant nuclei become repetitive, with increasing use of vowel-like sounds. Raspberry-like sounds also emerge, which can be described as “bilabial or labiolingual trills or vibrations” (Yeni-Komishian et al., 1980, p. 97). Previous research suggests that raspberries

occur mostly during feeding, as infants enjoy playing with and spitting food items out of their mouths while they eat. However, raspberry vocalizations have also been observed outside of the context of feeding, indicating that raspberries are playful vocalizations (Yeni-Komishian et al., 1980). Vocalizations that occur in a higher-than-modal pitch range are called “squeals,” which are very common during the expansion stage (Yeni-Komishian et al., 1980). Squeals can be produced in response to tickling, another form of vocal play, or for no particular reason.

Growling is a vocalization produced in lower-than-modal pitch range. Growls are typically classified as “low-pitched” and “creaky” (Yeni-Komishian et al., 1980). Infants also begin to yell and whisper in this stage, exploring the range of amplitude changes available in speech production. Further, marginal babbling is observed, which does not follow mature syllable shapes and timing, but contains closure of the vocal tract (Yeni-Komishian et al., 1980). ASHA (2017) reports that during this stage, infants show an increase in use of laughter and gurgling while playing.

Infants reach the canonical stage of vocal development between 7 and 10 months (Oller, 1980). Here, vocalizations become more well-formed and syllabic in timing, in alignment with the natural contours of language. The canonical stage includes reduplicated babbling (e.g., “mamama” or “dadada”). Reduplicated babbling is not yet words but does contain syllable categories that are contrastive enough to be recognized by caregivers as distinct units. Such recognition often compels parents to report that their child has begun talking (Buder et al., 2012; Yeni-Komishian et al., 1980). Between 7 months and 1 year of age, the infant may begin imitating words they have been exposed to, may consistently use several single-words, and may begin using their vocalizations to catch the attention of the caregiver (ASHA, 2017).

Variegated babbling begins to emerge in infant sound productions around 11 and 12

months of age (Yeni-Komishian et al., 1980). Unlike reduplicated babbling, there is much more variation in these productions. They follow the syllabic contours of speech and include diversity in consonant and vowel productions, which results in gibberish or long strings of nonsense words (Yeni-Komishian et al., 1980).

Nathani, Ertmer, and Stark (2006) provide yet another classification scheme by organizing infant sounds into levels according to their expected age of development. Nathani and colleagues used the Stark Assessment and Evaluation of Vocal Development (SAEVD-R), a research-based tool, to categorize the various vocalizations infants produce in the first 20 months of life. The first level on the SAEVD-Revised, the Reflexive Level, includes: fussing, crying, and vegetative sounds. The sound productions produced in Level 1 are seen within 0 to 2 months of age (Oller, 1980; Stark, 1980). Level 2 of the SAEVD-R, Control of Phonation, includes vocalizations that are typically observed between 1 to 4 months of age (Oller, 1980; Stark, 1980). During this stage, infants demonstrate some control over the vocalizations they produce, eliminating any reflexive sounds from this stage. Types of vocalizations observed during Level 2 include: fully-resonant nuclei, vowel-like sounds, raspberries, chuckles, and glottal stops. The Expansion Stage, or Level 3, takes place from 3 to 8 months of age, and involves more adult-like vowel sounds, squeals, vowel glides, and marginal babbling. Mature, adult-like productions begin to emerge between 5 and 10 months of age, or the Basic Canonical Syllables level (Level 4) of the SAEVD-R. Whispers and canonical babbling are also observed within this stage. A child is at Level 5, the Advanced Forms stage, between 9 and 18 months of age. Use of whole words begins in this stage and non-word productions are complex in articulation and phonation. Vocalizations made during this stage suggest fine-tuned control over the vocal tract (Nathani et al., 2006).

Previous Research: Untrained Listener Classification of Infant Sounds

Given the wide variety of classification schemes for tracking of infant vocal development, and the potential for additional variety in caregiver report, we began work toward establishing a gold standard to enhance transparency across listeners. Perry (2016) conducted a master's thesis providing groundwork to develop a gold standard list for classification of infant sounds. Her study was completed to begin bridging the gap between the ways infant sounds are described in the clinical/research setting versus by caregivers who are not familiar with the field of SLP. Untrained individuals (caregivers) were played audio recordings of infant vocalizations, and asked to describe the sounds presented to them using one to three words. The vocalizations played to the participants included: vowels, squeals, growls, raspberries, whispers, cries, and laughs per traditional laboratory description.

Vocalizations were collected from 10 typically developing infants aged 4 to 12 months and played to 40 caregivers of middle socioeconomic status. All listeners were native speakers of American-English. Both mothers and fathers participated in the study. The participants responded to vowel vocalizations most often as “coo” “talk,” and “happy,” with “coo” as the most frequent response at 16.5%. When presented with what clinicians classify as “squeal” vocalizations, caregivers generated “squeal,” “happy,” and some derivation of “high” to describe it. The label “squeal” accounted for 26.7% of the responses, showing some consistency between SLP and caregiver description. Growls were classified by caregivers most often as “grunt,” “growl,” and “play.” “Grunt” was the most frequent response for growl stimuli at 17.1%. The raspberry stimuli were labeled most frequently as “raspberry,” “spit,” and “bubble.” The “raspberry” label appeared in 13.3% of the responses, making it the label that had the highest occurrence for the raspberry stimuli. Whisper stimuli yielded “whisper,” “talk,” and “breath” as

the three most common responses. Caregivers used “whisper” to describe the whisper stimuli 17.6% of the time; again showing consistency between untrained and trained groups. Cry stimuli were most often labeled as “cry,” “sad,” or “upset.” “Cry” was used most frequently (35.7%). Laugh stimuli elicited “laugh,” “happy,” and “giggle” as the three top descriptive terms, with “laugh” having an occurrence percentage of 33.7%. In total, the list composed by the untrained listeners to describe the various stimuli included coo, talk, happy, squeal, high, grunt, growl, play, raspberry, spit, bubble, whisper, breath, cry, sad, upset, laugh, and giggle, among other terms.

While a number of labels generated by untrained caregivers to describe the stimuli did not always match the labels SLPs would give, there was some consistency demonstrated between the two groups. For example, the following stimuli showed overlap between SLP and caregiver labels: squeal, growl, raspberry, whisper, cry, and laugh; 71.4% of the stimulus items were labeled similarly between SLPs and untrained individuals.

This study will be continued to further narrow down how untrained individuals classify infant sounds when they are provided a list of labels (generated by Perry, 2016). The continuation of this research will help to clarify how untrained individuals classify sounds produced by infants aged 4 to 12 months of age. Narrowing down the list of descriptive terms used to characterize each type of infant vocalization will show either similarities or differences between caregiver and SLP classification of infant sounds in hopes to generate a gold standard list between these individuals for labeling different types of vocalizations.

Methods

Infants

Vocalizations for this study were the same vocalizations used by Perry (2016), obtained from 10 typically developing infants, video/audio recorded monthly in a study conducted by Dr. Heather Ramsdell-Hudock at East Carolina University (ECU). All infants were from 4 to 18 months of age at the beginning and termination of the study, respectively. Flyers advertising the study were sent to addresses (obtained from Register of Deeds records at the Pitt County Court House, Greenville, NC) of families with infants born between November, 2010 and March, 2011. Parents interested in participating in the study with their infants were interviewed, and details of the study, along with informed consent, were discussed. Inclusion criteria for the study consisted of caregivers who experienced normal pregnancies and no significant history of prenatal or perinatal problems; families where English was the primary language spoken in the home; families who were able to travel to the laboratory monthly; families who did not expect to move away from the surrounding area within 2 years of beginning participation in the study; and infants not at risk for developmental disorders. For further clarification, infants considered at risk would have been those who had experienced one or more of the following conditions prior to 7 months of age: pre- and/or perinatal problems; ear, nose, and throat problems; swallowing/sucking problems; and/or a family history of speech and/or language problems (Brady, Marguis, Fleming, & McLean, 2004; Girolametto, Weitzman, Wiigs, & Pearce, 1999; Goldstein & Schwade, 2008; McDuffie & Yoder, 2010). For the purposes of this project (as with Perry, 2016), we explored data from 4 through 12 months of infant age. Following previous approval from the University Medical Center Institution Review Board at ECU, caregivers voluntarily gave informed consent for participation in the study. Further, exemption was

obtained from the Human Subjects Committee at Idaho State University (ISU), as the purpose of the present study was covered in the original consent.

All families were of middle socioeconomic status (as determined through parent self-report on participant history interview). There were no infant participants born to single parent homes, and both mothers and fathers participated in the original study. Five of the infants were first born, three had one older sibling, and two had three older siblings. Siblings ranged in age from 2 years to 5 years at the time of infant participants' births.

Three of the ten infant participants were male, and seven were female. One female infant was African American, one male infant was Asian American (father of East Indian descent and mother of Vietnamese and Hawaiian descent), and one male infant was Palestinian and the rest were Caucasian. One male infant was from a home where English and Arabic were spoken, and a second male infant was from a home where English, Indian, and Vietnamese were spoken. All infants had normal hearing; they all passed an automated auditory brainstem response newborn screening (ALGO 3 or ALGO 5 Newborn Hearing Screener System) to click stimuli presented at 35 dB nHL. In addition, full hearing evaluations including tympanometry, transient evoked otoacoustic emissions, and visual reinforcement audiometry were conducted at 6 and 18 months of age, with follow-up testing as needed for instances where results were abnormal (i.e., middle ear dysfunction) or testing was incomplete. One of the infants received bilateral myringotomy and pressure equalization tubes during their enrollment in the study.

List of Terms

A list of terms used to describe infant vocalizations by untrained listeners in Perry (2016) was generated for distribution to untrained listeners in the present study. The most frequently used terms to describe each unique infant vocalization (given laboratory staff classification of

vowel, squeal, growl, raspberry, whisper, cry and laugh) were put on the list (as shown in Appendix A). The list included the following 39 terms: squeak, growl, grunt, play, frustrated, cry, raspberry, spit, bubble, blow, fart, whisper, breath, quiet, mama, soft, sad, upset, mad, hurt, angry, hungry, unhappy, laugh, giggle, chuckle, vowel, coo, talk, happy, tired, content, babble, noise, sigh, squeal, high, excited, and pitch. This list was presented to listeners in print and reviewed with each participant before beginning the study.

Untrained Listeners

A total of 24 untrained listeners (20 females and 4 males) participated in the study, all from either The Bay Area, California, or Southeastern Idaho. Participants ranged in age from 23 to 39 years of age and had between 1 and 4 biological children. Listeners qualified as untrained if they have not been previously educated in linguistics, protophone terminology, SLP, child development, or music (to avoid bias based on previously trained listening skills). Additionally, all listeners were native speakers of American-English (per participant report) with normal hearing (as observed via a hearing screening conducted by the first author). We inquired about gender, age, and parenting/caregiver experience (based on number of biological children each participant had). Questions asked by participants before the start of the study included, “What does ‘pitch’ mean?”, “Do I point to it or say it?”, and “Do I have a time limit on how long it takes me to select one?” The author did not provide a definition for “pitch,” and instructed the participant to use their best judgement and interpret each of the terms on the list on their own. The author asked participants to verbally state their selections off the list, and no time limits were placed on the participants.

Procedure and Analysis

A randomized set of infant vocalizations from the archived data base was located based upon a breathe group criterion (each change in the direction of airflow corresponded with a new utterance; Oller & Lynch, 1992) and extracted from the original recording sessions to eliminate extraneous caregiver and lab staff productions, toy sounds, and vegetative infant sounds. Once infant utterances were located, they were coded for vocal type. Generally, laboratory staff were instructed to use as few listening opportunities as possible before assigning codes (no more than three). The reason for this instruction was for the researchers to assign codes intuitively based on salient characteristics; the most prominent impression of each utterance was used to determine judgment. For vocal type, utterances were coded as vowel, growl, squeal, raspberry, whisper, laugh, or cry. The coding was conducted without viewing video or TF32 spectrographic display of the utterances, as no visual support was allowed, so that viewing social interaction and the acoustic display did not skew coder judgment. Modal pitch across infants was judged intuitively by laboratory staff upon listening to vocalizations produced by each infant, and vocal type was coded accordingly. *Vowel* was coded if the utterance was perceived as predominantly produced in modal phonation, in the mid pitch range of the infant. *Growl* was coded if the most salient pitch of the utterance was notably lower than the infant's modal phonation, or if the pitch of the utterance was in the normal range but the utterance was produced with very high tension. *Squeal* was coded if the utterance was notably higher in pitch than the infant's modal phonation. *Raspberry* was coded if the infant produced any sort of lip or tongue trill. *Whisper* was coded if the infant produced a voiceless utterance with audibly perceptible articulatory movement. *Laugh*

was coded if laughing was the most salient characteristic of the utterance, and *cry* was coded if uncontrollable crying (more than fussing) was perceived as the most salient characteristic of the utterance. The vocalizations were vetted to make sure there was diversity of sound type, the full range of sound types in the first year, and the same sounds (e.g., squeals, growls, vowels, etc.) from every infant (to the extent possible, as some sounds were not produced by some infants at certain ages). One of each vocal type was selected from each infant at each age for presentation to untrained listeners (also to the extent possible). The distribution of these sounds across infant ages is displayed below in Table 1. Given technical difficulties in the present study, several of the sounds below were not included.

Table 1

Number of Infant Utterance Types to be Presented to Untrained Listeners

	Across Ages	Infant Age in Months								
		4	5	6	7	8	9	10	11	12
Vowel	58	8	6	7	6	4	5	7	8	7
Squeal	36	4	4	2	5	7	5	0	3	6
Growl	34	5	3	3	4	4	3	5	3	4
Raspberry	9	1	1	1	0	2	0	1	3	0
Whisper	7	0	0	0	0	0	2	2	1	2
Cry	25	7	1	4	4	4	2	0	0	3
Laugh	23	2	0	3	3	3	1	3	4	4
Total	192	27	15	20	22	24	18	18	22	26

All participants were administered a hearing screening by the first author. Once they passed the hearing screening, they were given further directions. The untrained listeners were read the same script to ensure all participants received the same instructions (as shown in Appendix B). The untrained listeners were then played 163 vocalizations (audio recordings through QuickTime Media Player), some from each infant at each age, presented randomly. Audio recordings included 22 clinician-classified *cry* vocalizations, 29 *growls*, 18 *laughs*, 8 *raspberries*, 31 *squeals*, 49 *vowels*, and 6 *whispers*. Participants were prompted to identify which term best describes the vocalization presented from the previously generated list of 39 terms

provided. Four randomized sound-order lists were generated and each list was presented to 6 of the listeners. To avoid biasing, no examples were provided. Before beginning with the audio recordings, any questions that participants had, participant gender, participant age, and participant number of children were documented. Each of their responses was recorded for analysis. The listeners were blinded to infant and infant age. Listener responses were explored for themes and patterns within and across reports were identified to determine gold standard terminology.

Results

Overall, some overlap was observed between untrained parent/caregiver's labeling of sounds when compared to terms used by clinicians. Specifically, when looking only at the clinician-classified vocalization types cry, growl, laugh, raspberry, squeal, vowel, and whisper and how often the parents used these exact terms in labeling said sounds, similarity was apparent. For example, given options of cry, growl, laugh, raspberry, squeal, vowel, and whisper, clinician-classified *cries* were labeled "cry" by the untrained listeners most frequently, *growls* as "growl," *laughs* as "laugh," and so on, as demonstrated in Table 2.

Table 2

Frequency of Use of Clinician-classified Terms by Untrained Listeners

		Vocalization Type						
		Cry	Growl	Laugh	Raspberry	Squeal	Vowel	Whisper
Untrained Listener Labels	Cry	89	1	4	0	2	1	0
	Growl	6	83	2	2	2	2	0
	Laugh	4	0	87	0	0	0	0
	Raspberry	0	0	0	59	0	0	0
	Squeal	16	0	3	0	243	0	0
	Vowel	10	1	3	0	5	9	0
	Whisper	0	0	0	0	0	1	33

When examining the most frequently used labels by caregivers across *all* response options (as opposed to across only clinician-classified vocal types), differences between listener

responses were present. In fact, there was correspondence across classification types between listeners only 6.3% of the time. *Cries* were labeled by parents most often as “upset” 118 times (22% of the time), “cry” 89 times (17%), and unhappy 74 times (14%). *Growls* were described by caregivers as “grunt” 190 times (in 28% of presentations), “growl” 83 times (12%), and “talk” 47 times (7%). *Laughs* were labeled as “giggle” 103 times (32% of trials), “laughs” 87 times (27%), and “chuckle” 36 times (11%). *Raspberries* were labeled as “raspberry” 59 times (31% of the time), “bubble” 36 times (19%), and “spit” 35 times (18%). *Squeals* were labeled as “squeal” 243 times (33%), “excited” 64 times (9%), and “squeak” 62 times (8%). *Vowels* were labeled “talk” 219 times (19%), “coo” 137 times (12%), and “content” 133 times (11%). *Whispers* were labeled as “whispers” by caregivers 33 times (23% of the time), “talk” 31 times (22%), and “quiet” and “breath” each 15 times (10%). Response frequencies are displayed in Table 3.

The terms “talk,” “squeal,” “grunt,” “upset,” “babble,” “coo,” and “content” were used most frequently throughout the study. “Talk” was used 8% of the time, “squeal” 7% of the time, “grunt” 6% of the time, “upset” 5% of the time, “babble” 5% of the time, “coo” 5% of the time, and “content” in 4% of trials. Of the most frequently used terms, “talk,” “babble,” “coo,” and “content” were all mostly descriptions provided by the untrained listeners to label clinician-classified *vowels*. Given that *vowels* were presented more than any other vocalization type in this study (49 utterances), this may explain the reason for frequency of these labels. “Squeal” was most often used to label clinician-classified *squeals*, and “grunts” were used most often to label clinician-classified *growls*. As previously stated, “upset” was used to describe *cry* vocalizations.

All of the terms on the provided list were used at least once throughout the study. Of the available choices, “mama,” “vowel” and “high” were the 3 terms used least frequently – each of them used less than 1% of the time. “Mama” was used in 0.13% of opportunities to label *cry*,

vowel, and *whisper* vocalization types. “Vowel” was used to describe *cry*, *growl*, *vowel*, and *whisper* vocalizations in only 0.34% of trials. “High” was used 0.42% of the time to label *squeals*, *vowels*, and *whispers*. Errors in audio playback were observed in 0.24% of presentations.

Table 3
Frequency of Use of Terms by Untrained Listeners

		Vocalization Type						
		Cry	Growl	Laugh	Raspberry	Squeal	Vowel	Whisper
Untrained Listener Labels	Angry	17	11	0	0	16	0	0
	Babble	0	36	3	2	15	117	12
	Blow	0	6	0	21	1	0	0
	Breath	0	14	1	0	0	5	15
	Bubble	0	4	0	36	0	1	0
	Chuckle	6	2	36	0	0	1	0
	Content	0	22	3	1	7	133	4
	Coo	0	14	0	5	14	137	2
	Cry	89	6	4	0	16	10	0
	Excited	4	32	9	0	64	27	0
	Fart	0	5	1	31	0	1	0
	Frustrated	50	34	1	0	58	24	0
	Giggle	6	2	103	0	4	2	0
	Growl	1	83	0	0	0	1	0
	Grunt	2	190	15	0	3	35	0
	Happy	4	27	32	1	39	65	2
	High	0	0	0	0	13	2	1
	Hungry	22	8	3	0	5	20	0
	Hurt	36	2	0	0	2	1	0
	Laugh	4	2	87	0	3	3	0
	Mad	23	6	0	0	12	0	0
	Mama	2	0	0	0	0	2	1
	Noise	3	22	3	1	19	103	10
	Pitch	1	0	0	0	24	3	0
	Play	2	38	6	0	18	35	2
	Quiet	0	2	0	0	0	7	15
	Raspberry	0	2	0	59	0	0	0
	Sad	34	6	3	0	8	17	0
	Sigh	0	6	0	0	6	52	6
	Soft	0	1	0	0	0	25	8
	Spit	0	4	0	35	0	2	1
	Squeak	0	0	0	0	62	1	0
	Squeal	2	2	0	0	243	5	0
	Talk	5	47	0	0	20	219	31
	Tired	18	17	4	0	17	55	0
	Unhappy	74	12	2	0	22	39	0
	Upset	118	19	8	0	33	12	0
	Vowel	1	2	0	0	0	9	1
	Whisper	0	0	0	0	0	0	33
	Error	4	0	0	0	0	5	0

Discussion

The purpose of this study was to determine a gold standard list of the most frequently used terms by untrained listeners to describe clinician-classified *vowel*, *growl*, *raspberry*, *squeal*, *cry*, and *laugh* vocalizations produced by infants from 4 to 12 months of age. The findings indicate that while caregivers may not use the same terms that clinicians are using upon first instinct, when they do use these terms, they are using them similarly. Additionally, it appears that untrained listeners prefer to label the vocalizations by attempting to interpret the meaning or emotion behind each presented sound. For example, *cry* vocalizations were most often classified by parents/caregivers as “upset,” “unhappy,” and “frustrated”. It is important to recognize that while assigning emotional meaning to the utterances, the top-provided responses for cry carry a negative connotation, which is consistent with how *cry* vocalizations are interpreted across settings. Several participants stated that they wished they could combine two terms off the provided list as their response (e.g., “hungry cry” or “tired cry”) to the stimuli. Others stated that supplemental video footage would be helpful in their selections because they “couldn’t tell if the sound was happy or sad without seeing the infant’s face.” Similar trends were observed in response to *squeal* vocalizations, labeled as “excited” or “frustrated”. *Whispers*, *raspberries*, *growls*, and *laughs* received more concrete, action-type descriptors. For example, *whispers* were often labeled “whisper” or “talk;” *raspberries* were labeled “spit,” “blow,” or “fart;” *growls* were labeled “grunt,” “growl,” or “talk;” and *laughs* were labeled “giggle,” “laugh,” or “chuckle”. *Vowels* received a combination of emotional and action labels by the untrained listeners, such as “talk,” “coo,” and “content”.

The most common words used per vocal type were: “upset” for *cries*, “grunt” for *growls*, “giggle” for *laughs*, “raspberry” for *raspberries*, “squeal” for *squeals*, “talk” for *vowels*, and

“whisper” for *whispers*. While all labels provided by caregivers were not the exact same as the clinician-classified terms, the terminology offered by the caregivers was similar. For example, the terms “upset” and “cry” are not the same, but they are similar and represent comparable behavioral states of an infant. This is also present in the terms “grunt” and “growl,” which have similar meanings and are sometimes used interchangeably. “Giggle” is also a term commonly used to describe “laughs.” Overall, while the terms provided by the untrained listeners may differ slightly from clinician-generated verbiage, we can conclude that caregivers are using labels that have the same (or similar) meanings to the clinician-classified words.

The previously collected infant vocalizations used in this study contained recordings from infants between 4 to 12 months of age. Vowels made up 30% of these audio recordings; infants within this age group produced substantially more *vowels* when compared to other vocal types. That being said, *vowels* were also classified by untrained listeners with the most variability across sound types. For example, vowels were described using 35 different labels from the presented list of terms, whereas vocal types such as *raspberries* and *whispers* were described using only 10 and 16 different labels respectively. Out of the 35 different terms used to label *vowels*, clinician-classified “vowel” was used as a descriptor by untrained listeners in only 9 presentations (1% of the time). This demonstrates a discrepancy between clinician use of the term *vowel* and the way parents label *vowels*. The term *vowel* is used widely in the field of speech-language pathology by clinicians and researchers alike, and untrained listeners classified *vowels* most often as “talk,” “coo,” and “content.”

Given the presented findings, a gold-standard list of terms for clinicians and researchers to use with untrained individuals was generated. This list of terms was produced with consideration of the labels most often used by untrained listeners to describe each vocal type, and with

consideration of the similarity of the offered labels to clinician-classified terms. The gold-standard list of terms for each presented vocal type is presented in Table 4.

Table 4
Gold Standard Terms per Vocal Type

	Vocalization Type						
	Cry	Growl	Laugh	Raspberry	Squeal	Vowel	Whisper
Gold Standard List	cry	growl	laugh	raspberry	squeal	coo	whisper

It is best to refer to *cry* vocalizations with untrained listeners as “cry.” While *cries* were most often labeled by parents as “upset,” the proximity of the typical interpretation of these terms indicates that using “cry” to label *cries* will not create miscommunication. Additionally, “cry” was the second-most used label by caregivers to describe this vocal type.

Growls were most commonly labeled as “grunt” by untrained caregivers. “Growl” was determined to be the most appropriate label for this vocal type, given its similarity to the term “grunt.” “Growl” may carry the connotation that these utterances are longer in length, whereas a “grunt” might be thought to represent a shorter, quicker vocalization. “Growl” was also the second-most frequent term used by parents to label these sounds, which tells us that parents do use this term to describe infant vocalizations accurately.

Laughs were most often labeled as “giggle” by untrained listeners. The next most frequently used term to label these infant utterances was, indeed, “laugh.” Many individuals may use the terms “giggle” and “laugh” interchangeably. For the purposes of consistency and due to the similarity of the terms “giggle” and “laugh,” “laugh” was determined to be the best label to describe *laugh* vocalizations.

Raspberry vocalizations were most often classified by untrained listeners as “raspberry.” Given that the most frequently used term by parents was consistent with the clinician-classified term, “raspberry” is the gold-standard term to describe this vocal type.

Similarly, *squeal* vocalizations were also labeled by caregivers most often in the same manner as clinicians describe them (i.e., as “squeal”). “Squeal” was deduced to be the most-fitting term to use when describing *squeals*.

Vowel sound-types, which had the most variety in terms of descriptors offered by parents, were decidedly best classified as “coo” sounds. “Talk” was the most frequently used term to describe *vowel* sounds, but “coo” was next in terms of frequency. Given the variability of the labels chosen by untrained listeners, and the generality of the term “talk,” “talk” did not appear to be the most concrete, easy to interpret label. For example, “talk” was used by caregivers 322 times to describe 5 different vocal-types, including *cries*, *growls*, *squeals*, *vowels*, and *whispers*. “Coo” was used to describe the same vocalizations only 172 times. “Coo” seems to be used more specifically by untrained listeners to describe clinician-classified vowels.

Whisper sounds were labeled most frequently as “whispers” by untrained listeners. Due to the frequency in use of the terms and limited variability in the labels chosen, “whisper” is the best term to use when labeling *whispers*.

Clinical Implications

The results of this study tell us that clinicians and caregivers are generally describing infant vocalizations in the same manner. While some differences were observed, we can conclude that the terms caregivers offer hold the same meaning as clinician-generated terms. Since we know that caregivers *are* using the clinician-classified words appropriately when they do use them, we can accurately probe parents and provide multiple choice options during the

assessment process if needed, and expect to get accurate descriptions of their baby's vocalizations in response. We now know that untrained listeners prefer to label some sound types more emotionally rather than by the type of sound they are, and can use this information to increase accuracy in assessment and treatment as well. For example, if a caregiver describes an infant utterance as "upset" or "unhappy," we can ask more clarifying questions to determine if the infant exhibited a *cry* vocalization.

Study Limitations

This study's primary limitation is its small sample size. Additionally, participants were only recruited from two locations, Southeastern Idaho and Northern California, which could have skewed caregiver's responses. Additionally, all of the recruited participants were native speakers of American English, which creates a lack of language diversity among participants and may have influenced results. Further, inconsistency in audio playback of two infant vocalizations was noted and resulted in a lack of response in 9 instances across the entire study.

Future Directions

Future research may involve a larger sample size of participants from a larger variety of geographic locations. Participants in future studies may also come from more diverse language backgrounds to determine if primary language impacts how untrained listeners classify infant vocalizations. It would also be interesting to parse out sounds by infant age and see how that aspect influences the labels of the untrained listeners. Providing shorter list of terms for the caregivers to choose from (such as only giving them clinician-classified words; squeal, cry, growl, laugh, raspberry, vowel, and whisper), and observing if they still accurately label the sounds given a reduced field of choices to choose from.

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Appendix A

List of words presented to participants.

Vowel	Squeak	Quiet
Coo	Growl	Mama
Talk	Grunt	Soft
Happy	Play	Sad
Tired	Frustrated	Upset
Content	Cry	Mad
Babble	Raspberry	Hurt
Noise	Spit	Angry
Sigh	Bubble	Hungry
Squeal	Blow	Unhappy
High	Fart	Laugh
Excited	Whisper	Giggle
Pitch	Breath	Chuckle

Appendix B

Script read to participants.

First of all, thank you for participating in this project. It may seem odd that I'm reading to you right now, but I have to follow a script to ensure that all participants receive the same information.

We'll begin today by conducting a hearing screening. If you pass the hearing screening, I'll play a number of baby sounds to you, and have you select a term from this list that best describes each sound. All terms on the list can be used as many times as needed.

For each baby sound, you will provide a response that I will record on my computer. We will spend 30 to 60 minutes doing this.

The task may be challenging, as you probably haven't always thought of how to describe baby sounds. However, I can't provide you with an example because I don't want to skew your responses. Please just try to describe the sounds as best you can given this list of options. We would like a response for everything.

Now I'm going to read the list of words with you so you know what your options are. READ LIST OF WORDS

Do you have any questions? RECORD ALL QUESTIONS

I need to begin by recording your gender, age, and number of children.
BEGIN