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Development of a Screening Instrument for Caregiver Report of Infant Speech Patterns

By

Brittany Thomas

A thesis to be

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 2020

Committee Approval

To the Graduate Faculty:

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

_____

Name, Major Advisor

_____

Name, Committee Member

_____

Name, Graduate Faculty Representative

Human Subjects Committee Approval

March 5, 2020

Heather Ramsdell-Hudock
College of Rehabilitation Comm Sciences
MS 8116

RE: Study Number IRB-FY2020-175: Development of a Screening Instrument for Caregiver Report of Infant Speech Patterns

Dear Dr. Ramsdell-Hudock:

Thank you for your responses to a previous review of the study listed above. I agree that this study qualifies as exempt from review under the following guideline: Category 2.(i). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording).
The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects.
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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

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Development of a Screening Instrument for Caregiver Report of Infant Speech Patterns

Thesis Abstract—Idaho State University (2020)

The purpose of this project was to develop a screening instrument for caregiver report of infant speech patterns from 7 to 18 months of age. The Human Subjects Committee at Idaho State University approved this study. Based on archived longitudinal data of caregiver report of infant speech sounds from 26 families, we identified commonly reported sounds/sound sequences and developed a screening instrument highlighting these sounds. The screener was revised in accordance with feedback from 6 experts and 7 caregivers. For collection of preliminary data, 50 packets were delivered to a pediatric clinic for distribution to families. Participants will also provide developmental milestone and demographic information and complete the *MacArthur-Bates Communicative Development Inventory – Words and Gestures* (CDI; Fenson et al., 2006). We will compare screener results to CDI (Fenson et al., 2006) results to validate the instrument, and to developmental milestone data to see how sound inventories align with developmental status. It is hypothesized that infants who perform more strongly on the CDI (Fenson et al., 2006) and classify as typically developing according to questionnaire responses will be reported to produce more variety in terms of the quantity and quality of their vocalizations. Here, we report on development of the screener. Clinical implications for such a screener could include earlier identification of children considered at-risk, more efficient methods of assessment for speech-language pathologists, and ease of use in clinical or home settings with or without professional administration. Study limitations and future directions will be discussed.

Key Words: screening instrument, infant vocalization, infant speech sound, caregiver report

Development of a Screening Instrument for Caregiver Report of Infant Speech Patterns

Infant speech patterns have been shown to be indicators of future speech and language development, both typical and atypical (Lyakso et al., 2014; Oller et al., 1999; Sotto et al., 2014). Oller and colleagues (1999) found that infants who do not start producing canonical babbling by 10 months may be at risk for decreased production when reassessed at 18, 24, and 30 months of age. Furthermore, the frequency of infant vocalizations at 9 months of age has been shown to have a significant correlation with the number of words spoken at 12 months of age (Lyakso et al., 2014). Additionally, toddlers who produced one or more fricatives at 18 months had more advanced language skills at 24 and 30 months when compared with peers who did not use fricatives. Fricative use could potentially be an indicator of a child's language skills, although more research is necessary before development of procedures to support production of consonants in early intervention (Sotto et al., 2014).

Infant Vocalizations

When discussing infant vocalizations, an ordered and predictable sequence of emergence is presented for typical development (Morgan & Wren, 2018). The first 6 months of an infant's speech development consist of vegetative sounds, cooing, and vocal play. During this time, establishment of early breath support for speech production, and early manipulation of the phonatory and resonatory characteristics of speech occurs. This period of vocal development does not consist of recognizable consonant-vowel (CV) syllable structures that we hear produced regularly in adult speech. Around the 7th month of life, the infant's vocal patterns change to include canonical syllables. Canonical babbling occurs when the infant starts producing recognizable syllables with CV structure ("ma", "ba"; Morgan & Wren, 2018; Stoel-Gammon & Otomo, 1986). Unlike the fuzzy sounding consonant-like and vowel-like segments produced

earlier in development, with slow, audible transitions, canonical syllables include clearly articulated consonants, fully resonant vowels, and a timely transition between vowel and consonant segments. Typically, with the production of canonical syllables comes reduplicated babbling, characterized by infant utterances that contain repetitions of well-formed CV syllables (Morgan & Wren, 2018). Then, seen around 10 to 12 months of age, infants begin variegated babbling, which includes a variety of CV pairings with adult-like intonation ("maboda"; Morgan & Wren, 2018). The productions are often referred to as "gibberish"; they resemble the intonation patterns of adult conversation but contain no meaningful words. Around the first year of life, the infant who is typically developing will begin to produce words. These words may not be perfectly articulated, but they often resemble the adult-like pronunciation and are understood by caregivers[1] and those who have regular interaction with the infant (Oller et al., 1999). By 18 months of age, children are producing some words with consistency, attempting new words (perhaps by imitation) regularly, and adding to their vocabulary on a steady basis (Oller et at., 1999).

Infant utterances, therefore, change with age. They also vary dependent upon the context in which they are produced. Iyer et al. (2016) conducted a study to examine the volubility of infants in three situations at different age ranges. Participants included 16 infants recorded from 2 to 11 months in age. All the participants passed newborn hearing screenings, were considered typically developing (per pediatrician report), and were from families of middle to high socioeconomic status (SES). Infants were fitted with a customized vest that held a wireless microphone for 30-minute recordings across three different social situations. The social

[1] For the purpose of this research, "caregiver" is defined as any person that is involved in the primary caretaking of the infant.

situations included No Talk, Talk, and Interview. During No Talk, the caregiver was in the room with the infant but was engaged in some other quiet activity (e.g., reading a magazine) while the infant played with age appropriate toys. During Talk, the caregiver was instructed to talk and interact as they would naturally with their infant. During Interview, an experimenter interviewed the caregiver about developmental and vocal milestones as the infant played in the room with age appropriate toys (Iyer et al., 2016). Researchers discovered that infant utterances were produced more frequently in situations where a caregiver was in the room and interacting with the infant, or doing a silent activity, as opposed to when a caregiver was in the room and engaging with a researcher in an interview. Infant utterances produced while the caregiver was interacting with another adult during the interview were stable across all age ranges, whereas utterances produced while the caregiver was interacting with the infant decreased as the age of the child increased (Iyer et al., 2016).

Caregivers are highly attuned to the speech of their infants and can recognize developmental changes in their child's speech patterns. When using canonical babbling as a milestone, caregivers can easily identify when their child enters this stage of vocal development (Oller et al., 1999). The ability of caregivers to easily identify canonical babbling indicates that caregiver report may be a reliable way to assess an infant's speech development.

Caregiver Report

Ramsdell-Hudock and colleagues (2018) conducted research to determine if caregiver report of infant babbling would mirror established norms. Research participants for the study consisted of 15 caregiver/infant dyads from 7 through 18 months of infant age. Exclusion criteria for participants included families who did not speak English at home, infants who were considered "at risk", families who may move in less than 2 years, and families that could not

travel to the clinic once a month. Researchers followed the 15 caregiver/infant dyads over a 13-month period with weekly interviews and monthly recordings. The interviews took approximately 5 minutes to conduct, and the main interview question was, “What sounds/words is your infant producing?” (Ramsdell-Hudock et al., 2018, p. 167). Responses from the caregivers were phonetically transcribed. Results of the study indicated that caregiver report closely mirrored established norms. Accordingly, Ramsdell-Hudock and colleague’s (2018) suggested that caregiver report is a valuable, yet untapped, tool for early identification and clinical application. Although no screening instrument for the emergence of speech sounds in infants 7 to 18 months of age exists, caregiver report has routinely been employed reliably with older children starting around 2 years of age.

In unpublished thesis work, Farnsworth (2019; under the guidance of Ramsdell-Hudock) conducted a study to determine if caregiver report of infant vocalizations predicts later vocabulary ability. Participants included 25 caregiver/infant dyads, 15 who were considered typically developing and 10 who were considered at risk between the ages of 7 and 18 months of age. In this line of research, “at risk” is defined as infants who experienced any of the following conditions prior to 6 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 et al., 2004; Farnsworth, 2019; Goldstein & Schwade, 2008; McDuffie & Yoder, 2010, Ramsdell-Hudock et al., 2018). Between 7 to 12 months of infant age, the main question of interest posed to caregivers for Farnsworth’s study was, “What sounds/words is your infant producing?” (2019, p. 14). The caregiver’s responses to the question were phonetically transcribed and tallied for the total number of utterances reported as well as the total number of consonants and vowels in those utterances (Farnsworth, 2019). Consonants were analyzed

according to place of articulation, voicing, and manner of production. Vowels were analyzed in terms of tongue position. Vocabulary ability at 18 months of age was determined via responses to the CDI (Fenson et al., 2006).

Multivariate analysis of covariance results demonstrated that caregiver report of vocalizations differed statistically significantly dependent upon infant developmental status after controlling for age [F (24, 82) = 5.647, p = 0.000, Wilks' Λ = 0.377, partial η^2 = 0.623], such that infants who were typically developing produced a larger number of sounds in each category explored than infants who were at risk per caregiver report. Cohen's d effect size results demonstrated that caregiver report of all early vocalizations across all ages from 7 to 12 months was related to later expressive (large to very large effects) and receptive (huge effects) vocabulary size at 18 months (0.2 = small effect, 0.5 = moderate effect, 0.8 = large effect, 1.2 = very large effect, 2.0 = huge effect; Cohen, 1988; Krueger & Heck, 2019; Sawilowsky, 2009). As measured through caregiver report in this sample, infants who were producing more vocal variability from 7 to 12 months of age were children with larger expressive and receptive vocabularies at 18 months. Despite the recurring link between early vocal abilities and later development demonstrated in published research, there has been limited implementation of this information in clinical practice. No screening tool focused on the emergence of speech sound production exists for infants from 7 to 18 months of age.

The Validity of Measures for Caregiver Report of Infant Ability after 18 Months

There has been abundant research validating the use of caregiver report in children older than 18 months of age (Feldman et al., 2005; Heilmann et al., 2005; Johnson et al., 2008). Validity and reliability are important terms when discussing research and development of any form of assessment, and thus should be clearly defined. Reliability is the degree or amount that a

measurement (screening tool) is replicable. A reliable tool would present consistent and stable results when administered repeatedly and over time (Kirk & Miller, 1986, as cited in Golafshani, 2003). Validity is the ability of a measurement (screening tool) to accurately measure the intended characteristic (Golafshani, 2003). Johnson and colleagues (2008) investigated the validity and diagnostic utility of the *Parent Report of Children's Abilities* (PARCA; Johnson et al., 2019), which was originally normed with 2-year-old toddlers born at, or near full term, and those born very pre-term. Participants included 164 infants born before 32 weeks gestation and their caregivers. Caregivers completed the PARCA-R (a modified version of the PARCA for very pre-term infants; Johnson et al., 2019) when their child reached 2-years adjusted age (the number of weeks the infant was born premature subtracted from their chronological age). At this time, caregivers were also contacted to arrange formal assessment with two psychologists using the *Bayley Scales of Infant Development – 2nd Edition* (BSID-II; Bayley, 1993). After analyzing the data, researchers indicated that the PARCA-R (Johnson et al., 2019) was a valid measure due to the present studies subtest score correlation with the original validation study. The researchers also looked at the diagnostic ability of the PARCA-R (Johnson et al., 2019) to identify toddlers with developmental delays. To do this, Johnson and colleagues (2008) compared the PARCA-R (Johnson et al., 2019) sensitivity (85%) to that of the BSID-II (Bayley, 1993) sensitivity (83%). Results from caregiver report on the PARCA-R (Johnson et al., 2019) aligned with those obtained by trained, medical-professionals on the BSID-II (Bayley, 1993), indicating that the PARCA-R (Johnson et al., 2019) can be used as a valid tool in of toddlers with developmental delays.

In addition to the PARCA-R (Johnson et al., 2019), the CDI (Fenson et al., 2006) is entirely based on caregiver report and has undergone rigorous testing by multiple researchers to

assess its validity in identifying young children with language delay (Feldman et al., 2005; Heilmann et al., 2005). The CDI- *Words and Gestures* (CDI-WG; Fenson et al., 2006) is used to assess infants 8 to 16 months of age in vocabulary, communicative gestures, symbolic behavior, and nonverbal imitation. The CDI- *Words and Sentences* (CDI-WS; Fenson et al., 2006) is used to assess children 16 to 30 months of age in expressive vocabulary, irregular word forms, overgeneralization of word endings to irregular verbs and nouns, and syntax. For children aged 30 to 42 months the CDI-III (Fenson et al., 2006) is utilized to evaluate expressive vocabulary, syntax, and language use (Feldman et al., 2005). Feldman and colleagues (2005) studied the validity of caregiver report via the various CDI (Fenson et al., 2006) formats using participants in an ongoing study of child development in relation to otitis media. All participants were seen at one of eight pediatric practice sites in the Pittsburgh, PA area from May, 1991 to December, 1995, were enrolled in the otitis media study by 2 months of age, and were deemed to be typically developing (not considered at risk). Participant caregivers completed the corresponding CDI (Fenson et al., 2006) when their children were roughly 1 and 2 years of age. Only a portion of participants completed the CDI-III (Fenson et al., 2006) because it was developed during the study. Each CDI (Fenson et al., 2006) was independently scored by two trained research assistants. Discrepancies were resolved by discussion. Participants were formally assessed at 3 years of age by a qualified professional or graduate student using the *McCarthy Scales of Children's Abilities* (McCarthy, 1972) and the *Peabody Picture Vocabulary Test – Revised* (PPVT-R; Dunn, L. M., 1981). A spontaneous speech sample was also gathered and later analyzed using the *Systematic Analysis of Language Transcripts* (SALT; Miller, & Iglesias, 2005) during 15 minutes of free play. Feldman and colleagues (2005) reported positive and statistically significant correlations between all CDI (Fenson et al., 2006) forms and other

measures used for language assessment at 3 years of age. Researchers concluded that, “The predominance of the evidence suggests that parents are reasonably good informants about their child’s expressive language development…” (Feldman et al., 2005, p. 865).

Further studies have explored the reliability and validity of the CDI (Fenson et al., 2006) when testing late talkers (LT). Heilmann and colleagues (2005) completed two studies of the CDI-WS (Fenson et al., 2006) in determining language skills of 30-month-old toddlers who had been identified as LT. In the first study (Study 1), concurrent validity was assessed by comparing the CDI (Fenson et al., 2006) to standardized assessments and language samples. Heilmann and colleagues defined concurrent validity as, “…the degree of correspondence between reported language abilities and direct assessment of language functioning” (2005, p.40). In the second study (Study 2), accuracy of the CDI (Fenson et al., 2006) in classifying toddlers as typically developing or as LT was assessed. Accuracy was defined as the ability of the screening instrument to match the true number of toddlers as typically developing or LT with those reported by the screening instrument. Participants for both studies were part of a larger longitudinal study exploring specific language delay. Study 1 participants consisted of 38 toddlers, 12 girls and 26 boys, deemed to be LT at 24 months of age. These children were also deemed to be typically developing in all other areas of development besides language. Caregivers completed the CDI-WS (Fenson et al., 2006) close to their child’s second birthday. Toddlers were formally assessed in a clinical setting at 30 months of age over two 1-hour sessions, at which point caregivers completed the CDI-WS (Fenson et al., 2006) a second time. Concurrent validity was determined by comparing the CDI-WS (Fenson et al., 2006) and the formal assessments and language sample from 30 months of age. Heilmann and colleagues (2005) determined that the CDI-WS (Fenson et al., 2006) is a valid tool for assessment of 30-

month-old LTs when compared with direct observation (formal assessment and language sampling).

Study 2 consisted of 100 participants (38 from Study 1 who were LT, and 62 age-matched peers who were typically developing). Study 2 methods aligned with those from Study 1. The CDI (Fenson et al., 2006) effectively sorted toddlers into separate language groups (LT and typically developing). Accordingly, the conclusion was that caregiver report via the CDI (Fenson et al., 2006) can differentiate between typical and atypical language development (Heilmann et al., 2005).

Utility of Caregiver Report prior to 18 Months

While caregiver report has been shown to be an effective means for identifying milestones in speech development after 18 months of infant age, there is limited translation from research prior to 18 months of age to clinical practice (Oller et al., 1999; Ramsdell-Hudock et al., 2018). Research on language development has been conducted to verify the validity of caregiver report for children prior to 18 months of age. As part of a larger study, 728 caregivers completed the *Communication and Symbolic Behaviour Scales – Developmental Profile* (CSBS-DP; Wetherby & Prizant, 2002) infant-toddler checklist at 8 and 12 months of age for their infants. The CSBS-DP (Wetherby & Prizant, 2002) was created to measure functional communication skills in children aged 6 months to 2 years, with the Infant-Toddler Checklist designed to specifically screen for early communication delays based on caregiver report and the Behaviour Sample to screen for early communication delays based on direct observation by a clinician (Eadie et al., 2010). The research was conducted to determine the validity of the CSBS-DP (Wetherby & Prizant, 2002) for caregiver report (Infant-Toddler Checklist) and direct observation (Behaviour Sample). Researchers used confirmatory factor analyses to examine

structure of the CSBS-DP (Wetherby & Prizant). According to Eadie and colleagues, "Correlations between the Infant-Toddler Checklist and the Behaviour Sample on the total, composite, and subscale scores were also calculated" (2010, p. 527). Direct observation (Behaviour Sample) and caregiver report (Infant-Toddler Checklist) were both valid tools for measuring early communication skills in infants at 12 months of age (Eadie et al., 2010).

To further support the validity of caregiver report, Ramsdell et al. (2012) suggested that caregiver report is more useful than phonetic transcription of infant vocalizations by a researcher. The rationale for this argument was multifold. Caregivers listen to their infants' vocalizations more naturally than those transcribing infant sounds, they hear all of what the infant produces but largely attend to and report the sounds that are repeated and/or more mature. As such, the sounds they report their infants to produce are functional, given that caregivers respond to canonical (more mature) vocalizations with words, therefore facilitating early word learning. Phonetic transcription is time consuming, challenging, unreliable (the phonetic alphabet was designed for documentation of mature sounds and infants do not make mature sounds), and results in a very detailed picture of the infant's phonetic repertoire with report of sounds that may or may not be functional for word learning. To support this position, Ramsdell and colleagues (2012) recorded babbling from 8 infants who were typically developing (with no significant history of prenatal or perinatal problems) at 8, 10, and 12 months of age. The authors explored vocalizations through 1) caregiver report, 2) clinical laboratory procedures that simulated the natural mode of listening used by caregivers, and 3) phonetic transcription. Results showed that phonetic transcription of the baby sounds produced what appeared to be an over-estimation of the infants' repertoires, particularly when compared to the substantially smaller reports provided by caregivers (Ramsdell et al., 2012).

With the previously conducted research provided as evidence to support that caregiver reports can be a valid and reliable means to assess infant and toddler development, this could be an effective and efficient solution to identifying infants who may be at risk for future speech and/or language delay/disorder at a younger age based on caregiver reports of sound production. Farnsworth (2019) demonstrated that more variability in infant speech sound production as reported by caregivers is positively correlated to vocabulary size at 18 months of age. This would indicate that a screening tool utilizing caregiver report on infant speech sounds can be an accurate predictor of future language development, specifically size for receptive and expressive vocabularies. This information could be used to differentiate between infants who are at risk and those who are typically developing. This early identification would give infants at risk the greatest chance for success, as early intervention has been linked with increased success and decreased time in therapy (Farnsworth, 2019). This screening tool could be a vital part of early intervention screening and therapy.

Development of a Screening Instrument

Screening instruments have been used consistently in clinical practice and research settings alike. Due to the prevalence of screening instruments, we can turn to published literature for procedural guidance on how to develop such a tool. Sheldrick and colleagues (2013) outlined their methodology in creating the *Baby Pediatric Symptom Checklist* (BPSC; Sheldrick et al., 2013). Given overlap in age of the target population (7- to 18-month-old infants), special considerations like those proposed by Sheldrick and colleagues (2013) could apply to development of an early speech sound screening tool. Accordingly, considerations included the ability of caregivers from a variety of cultural and educational backgrounds to answer the questions, ease of completing the questions in a clinical or home setting, and question constructs

that would be developmentally appropriate for the target population. After Sheldrick and colleagues (2013) developed an initial list of questions to include on their checklist, the questions were reviewed by eight caregivers who currently had young children and 11 experts in child development. Based on input from caregivers and experts, the questions were revised or discarded. This process resulted in 25 draft questions for the BPSC (Sheldrick et al., 2013). The questions were then screened for reading level using the Flesch-Kincaid computer analysis, with the average grade level of 2.1 determined. Finally, participants were recruited from primary care facilities by research assistants in the waiting room asking if caregivers were interested in participating in the research. Referral clinics, clinics where patients are referred for specialized care, identified possible caregivers through current health records. Once prospective caregivers were identified in referral clinics the physicians would send out a letter describing the study and asking for participation if interested. From the primary care and referral clinics, 259 participants were enrolled and completed the study (Sheldrick et al., 2013).

In collecting preliminary data for norming, the BPSC, participants were asked to complete the BPSC (Sheldrick et al., 2013) and other established assessments, such as the *Ages & Stages Questionnaire: Social/Emotional* (ASQ:SE; Squires et al., 2002). The other assessments tested the same targets and had previously been shown valid for older children. Sheldrick and colleagues (2013) used data collected from responses to the assessments to identify which questions were the most relevant for their screening instrument. Response to the 25 questions were organized and the frequency of each response category and any missing data was calculated. Items with less than or equal to 1% of missing data were eliminated. To test reliability, 68 participants were asked to complete the questionnaire again 4 weeks later. Validity was tested by comparing answers obtained on the BPSC to corresponding scores on the ASQ:SE

(Squires et al., 2002). Questions were eliminated that showed little validity and/or reliability, and remaining questions were compiled into a second version of the screening instrument. A new group of 146 participants was recruited from different primary care facilities and referral clinics for administration of the new inventory version in an attempt to replicate responses from the original group. According to Sheldrick and colleagues (2013) the responses were replicated adequately across the subscales. Using responses obtained from the two groups, a total of 405 participants, the researchers were able to establish norms for the BPSC (Sheldrick et al., 2013). This method of assessment development has been used to create and validate other caregiver report measures such as the *Preschool Pediatric Symptom Checklist* (PPSC; Sheldrick et al., 2012) and the CSBS-DP (Wetherby & Prizant, 2002). The procedures followed in developing an assessment in this manner have been deemed reliable (Eadie et al., 2010; Sheldrick et al., 2012; Thordardottir & Weismer, 1996). Due to the established validity and reliability of these procedures, we elected to follow similar procedures in developing a screening instrument for caregiver report of infant speech patterns.

Purpose

The ***long-term goal*** of this research is to establish a valid and reliable screening instrument for caregiver-report of infant speech patterns. This screening tool should have the flexibility to be completed by a caregiver or clinician (via caregiver interview). The results would then be interpreted by a speech-language pathologist to determine if an infant is presenting attributes that are within normal limits or are considered at risk for speech/language delay/disorder. The ***objective*** of the present proposal was to write questions for the screening instrument in preparation for future norming.

To develop a screening instrument for caregiver report of speech patterns from 7 to 18 months of age, we utilized archived data from two longitudinal studies of caregiver report of vocalizations from 1) 15 infants who were typically developing, and 2) 11 infants who were at risk for speech and/or language delay/disorder. It was ***hypothesized*** that we would be able to generate screener questions that would differentiate between those who are and are not typically developing in a preliminary sample of children. The hypothesis was formulated on the basis of 1) published research supporting caregiver report of child development after 18 months of age (Feldman et al., 2005; Heilmann et al., 2005; Johnson, et al., 2008; Oller et al., 1999) and 2) preliminary data supporting the utility of caregiver report of infant vocalizations prior to 18 months of age (Farnsworth, 2019; Ramsdell-Hudock et al., 2018). Development of a screener for caregiver report of infant speech patterns involved several systematic steps in order to ensure creation of a valid and reliable tool. However, given that caregiver report of infant vocalizations has been shown to predict later speech and language ability (Farnsworth, 2019; Lyakso et al., 2014; Oller et al., 1999; Sotto et al., 2014), the over-arching ***rationale*** of writing questions for a screening instrument was to lead to the validation of a screening instrument for future use of early identification of infants at risk for speech/language delay/disorder.

Keeping in mind that we wanted the screener questions to be 1) appropriate for caregivers from a variety of cultural and educational backgrounds, 2) easy to answer across a variety of settings, and 3) developmentally appropriate for children from 7 to 18 months of infant age, the hypothesis was pursued through exploration of the following four Specific Aims. We aimed to:

- ***Aim 1***, develop an initial list of screener questions based on archived longitudinal data of caregiver report.
- ***Aim 2***, have caregivers and experts review the questions.

- ***Aim 3***, revise or discard questions based on input from caregivers and experts.
- ***Aim 4***, screen questions for reading level using the Flesch-Kincaid readability scale analysis.

Methods

Overview

Due to the nature of the screening instrument (caregiver report), careful attention was placed on question generation. Sheldrick and colleagues (2012, 2013) looked at questionnaire constructs from caregiver reports that were already commonly in use. For example, some of the questionnaires they examined included the *Pediatric Symptom Checklist* (PSC; Jellinek et al., 1988), the *Child Behavior Checklist* (CBCL; Achenback, 1991), *The Brief Infant-Toddler Social and Emotional Assessment* (BITSEA; Briggs-Gowan & Carter, 2001), and the ASQ:SE (Squires et al., 2002). To generate appropriate question constructs, we started by examining questionnaires already targeted toward language development. These questionnaires included the CDI-WG (Fenson et al., 2006) and the CDI-WS (Fenson et al., 2006). After reviewing constructs of currently used questionnaires, we developed a bank of questions that address the anticipated differences between infants who are typically developing and those who are at risk. We also compiled a list of speech sounds from infants 6-9 months of age reported by caregivers. These questions and speech sounds were based on data from research conducted by Ramsdell-Hudock and colleagues (2018). These questions and speech sounds formed the basis of the initial draft of the Speech Sound Development Screener.

Initial Item Development and Description

The initial draft of the Speech Sound Development Screener can be found in Appendix A. To determine initial speech sound inclusion on the Speech Sound Developmental Screener,

the researchers used caregiver reports from two archived longitudinal studies conducted by Ramsdell-Hudock. These reports were from 26 caregiver/infant dyads who were recorded monthly from 7 to 18 months of age. The first group of participants included 15 infants who were considered typically developing (TD). The second group of participants included 11 infants who were considered "at risk" (AR); infants who experienced any of the following conditions prior to 6 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 et al., 2004; Farnsworth, 2019; Goldstein & Schwade, 2008; McDuffie & Yoder, 2010, Ramsdell-Hudock et al., 2018).

We started by identifying all unique utterances reported by the caregivers for both groups of infants, which resulted in 907 unique utterances. For example, /heɪ̯joʊ̯/, /dɪpʌdeɪ̯/, and /teɪ̯ntu/ were utterances reported by caregivers. Utterances were then narrowed to unique utterances of infants between 7 and 9 months of age, resulting in 254 unique utterances. These utterances tended to have more simplified syllable structures, as would be expected for infants of their age. For example, /heɪ̯/, /dɪ/, and /tæ/. Utterances were listed with the frequency of occurrences in caregiver reports for children who were TD and AR. To further refine the list of utterances, we went through a series of selection criteria resulting in an initial sample of 51 speech sounds and two non-standard speech sounds for spoken English. The inclusion criteria for sounds on the screener are presented in Table 1. On the screener, each speech sound was presented via transcription using the International Phonetic Alphabet and orthographically with descriptions. For example, /bɑ/ as in "**ba**ll". Instructions were written such that caregivers would select "yes" or "no" to indicate if their child says each speech sound.

Table 1

Speech Sound Inclusion Criteria for Initial Draft of the Screener

Inclusion Order	Selection Criteria
First	All utterances that occurred 6 or more times in TD* or AR** groups combined
Second	All utterances that occurred 5 or more times in TD and AR groups combined
Third	All utterances that occurred 4 times in one group and was said by both TD and AR groups
Fourth	All utterances that occurred 2 times in both TD and AR groups
Fifth	All utterances that occurred in both TD and AR groups
Sixth	All utterances produced 3 times by TD or AR groups.

*TD = Children who were typically developing.
**AR = Children who were at risk for developing a speech/language delay/disorder.

To assist in identifying speech sound development, the researchers included questions about the infant's vocal behaviors. Caregivers were asked to indicate "yes" or "no" if their child exhibited any of the behaviors and then to indicate the percentage (0-100% of the time) that their child participates in the behavior. Some examples of these questions included "Does your child cry?", "Does your child produce sounds while playing by himself/herself?", and "Does your child recognize his/her name?" Additional information that was asked of the caregiver to provide were the child's gender, birthdate, and the date of assessment completion.

Expert and Caregiver Review

The next step in item development was to have the initial draft of the Speech Sound Development Screener reviewed by a group that represents the target group (caregivers of infants from 7- to 18- months of age), and experts in the field (e.g., speech-language pathologists, child development experts, etc.). Reviewer comments were incorporated into the questions, with questions edited or eliminated accordingly. Upon completion of the initial draft of the Speech Sound Development Screener it was distributed to experts in the field and caregivers with infants between 7 and 18 months. We received feedback from 6 experts. Some suggestions included

incorporating “all corner vowels in all syllable contexts”, organizing by sounds starting with vowels and then consonants, and including voiceless stops. Another suggestion that was included from many experts was to refine the frequency measure from “0-100%” to something that was more easily understood, such as “always, sometimes, never”. This was also a common suggestion from the caregiver reviewers.

Caregivers of infants 7 to 18 months, from a variety of different economic and cultural backgrounds, were distributed the initial draft of the Speech Sound Development Screener and asked to identify things that could be changed to improve readability. Seven caregivers participated as reviewers. The most common suggestion was to change the frequency response from “0-100% of the time” to “always, sometimes, never”. Many of the caregivers suggested organizing the sounds by initial consonant. All caregiver reviewers indicated they felt they could complete the screener for their child.

Screener Revision and Readability

The final version of the Speech Sound Development Screener is attached in Appendix B. Based on suggestions by experts and caregivers, the Speech Sound Development Screener was revised for clarification and inclusion of further speech sounds. Corner vowels that had previously been excluded were included, as well as organizing vowels in isolation at the beginning of the screener. Consonant-vowel (CV) syllable structures were expanded to include outside vowels, if not previously present. Voiceless stops were added in CV syllable structures. No consonants in isolation were included as each consonant represented had multiple CV examples. As suggested by caregiver and expert reviewers, we revised the frequency scale at the beginning of the screener to clarify expectations. Caregivers would still select “yes” or “no” for

the specific vocal behavior, but were asked to also identify “always, sometimes, never” instead of a percentage of time during the day that their child engages in that behavior.

This revised set of questions was analyzed using the Flesch-Kincaid readability scale for reading level and ease of reading. According to Paasche-Orlow, Taylor, and Brancati (2003), the Flesch-Kincaid scale uses the average number of syllables and words per sentence to determine readability. The lower the score, the greater the readability. The Flesch-Kincaid analysis also includes a grade-level reading scale. This scale is based on American classroom reading levels with a level 1.0 corresponding to first grade and 12.0 corresponding with the final year of education before entering college or university (senior year of high school). For example, this thesis has a readability of 27.5 and a reading grade level of 14.0. The Flesch-Kincaid analysis has been used and tested for more than 2 decades and was determined by Paasche-Orlow and colleagues (2003) to be a valid and reliable measure of readability. The Flesch-Kincaid analysis is an automated part of Microsoft Word, and therefore readily available to the researchers and any researcher who would like to replicate the readability analysis. The overall reading level for the Speech Sound Development Screener was a 6.4, which was deemed acceptable based on the reading levels of other assessments for caregiver report (Eadie et al., 2010; Sheldrick et al., 2012). For example, the ASQ has an average reading level of 6.0 for questions (“Research Behind ASQ,” 2020). This is to ensure accessibility for all caregivers with a variety of educational backgrounds (Sheldrick et al., 2012, 2013).

Pilot Sample

Data collection for the pilot study is underway. Approval for the research was obtained from the Human Subjects Committee at Idaho State University. Participants for the pilot sample (n = 50) will include caregivers of infants from 7- to 18- months of age at the time of enrollment.

Researchers will recruit caregivers from diverse backgrounds to the extent possible given demographic norms in the surrounding area (e.g., the population in Pocatello, ID is 90% White, 1% Black, 1% Asian, 2% Native American, 3% mixed race, and 1% other race; U.S. Census Bureau, 2016). We prepared and delivered 50 research packets to the Pocatello Children's Clinic for distribution and future analysis will be conducted on responses received. Additional norming data will be collected in follow-up research on the project.

To recruit participants, we are working with the Pocatello Children's Clinic, from whom we received a letter of support. Clinic office staff ask caregivers of infants between 7 and 18 months of age, at the time of check-in, if they would like to participate in research being conducted. If caregivers choose to participate, they are given a packet containing the tools by which data are being collected, and a stamped/addressed envelope for return of the testing material. Caregivers can also voluntarily return contact information if they would like to be contacted by the researchers with results and a list of community resources as appropriate (for infants who are at risk for speech/language dely/disorder).

The distributed packets contain a Caregiver Letter explaining the research project (Appendix D), a letter for informed consent (Appendix E) the Speech Sound Development Screener (Appendix B), the CDI-WG (Fenson et al., 2006), a questionnaire to track demographic information and infant at risk status (Appendix C), and an addressed and stamped return envelope. The CDI-WG (Fenson et al., 2006) is included to assess validity of the Speech Sound Development Screener through comparison of results. To explore at risk status, a Family and Infant Background questionnaire (Appendix C) was designed for caregivers to return with the other assessments. This questionnaire assesses all aspects of risk as defined by the researchers. The Family and Infant Background questionnaire (Appendix C) is based on the assessment

development process used by Sheldrick and colleagues (2012, 2013). Participants are asked to complete the contents of the packet within 1 week and return completed forms to the researchers via the enclosed envelope.

Analysis of data will be completed by future researchers continuing with the project, upon receipt of assessments from caregivers at the Pocatello Children's Clinic.

Discussion

Previous findings show that children who are at risk use less fricatives at 18 months of age (Sotto et al., 2014), caregivers can identify speech production features in development (Oller et al., 1999), caregiver report of infant vocalizations is in line with published developmental patterns (Ramsdell-Hudock et al., 2018), caregiver report of infant vocalizations can differentiate between those who are typically developing versus those at risk for speech and/or language delay/disorder (Farnsworth, 2019), and caregiver report of infant vocalizations is predictive of later vocabulary ability (Farnsworth, 2019). To further explore the utility of caregiver report in identifying children for additional speech and language assessment, we set out to develop a screening instrument for caregiver report of infant speech patterns from 7 to 18 months of age. Specifically, we aimed to ***Aim 1***, develop an initial list of screener questions based on archived longitudinal data of caregiver report; ***Aim 2***, have caregivers and experts review the questions; ***Aim 3***, revise or discard questions based on input from caregivers and experts; and ***Aim 4***, screen questions for reading level using the Flesch-Kincaid readability scale analysis. Our ***hypothesis for Aim 1*** was that previous research from Ramsdell-Hudock and colleagues (2018) could be compiled into a list of questions that could be further refined. We were able to identify speech sounds and the frequency with which they were reported by caregivers from previously conducted research (Ramsdell-Hudock et al., 2018). This was then compiled into a list of

questions and formatted to allow caregivers the ability to indicate the speech sounds their infant was producing.

The ***hypothesis for Aim 2*** was that caregivers and experts would be able to provide valuable feedback to the researchers about the proposed questions. We were able to incorporate the feedback from experts and caregivers to refine the Speech Sound Development Screener. This led to a larger selection of speech sounds and CV syllable structures as well as clarifying directions for ease of caregiver completion. This in turn worked in conjunction with the ***hypothesis for Aim 3,*** that the feedback received from caregivers and experts would allow researchers to revise or discard questions. Based upon expert and caregiver feedback, we were able to increase the information being gathered with the Speech Sound Development Screener and improve its possible use in a clinical and/or home setting. The incorporated feedback helped to make the screener a more robust tool.

The ***hypothesis for Aim 4*** was that a set of questions could be created in a way that makes them accessible to a wide demographic of caregivers, specifically in relation to the readability and reading level of each question. Readability for the screener was determined using the Flesch-Kincaid readability scale. On the scale, the Speech Sound Development Screener was rated at a reading grade level of 6.4. This would indicate that it is accessible to an individual with reading abilities of a typical sixth grade student in their fourth month of school. This is similar to other assessments that utilize caregiver reports (Sheldrick et al., 2012).

We expect the long-term ***outcome*** of this research to be creation/use of a valid and reliable screening instrument for caregiver report of infant speech patterns from 7 to 18 months of age. We foresee that use of the screener will enable identification of children who are at risk for speech/language delay/disorder from ages 7 to 18 months and will be functional clinically to

identify children who may benefit from further assessment and early intervention. The screener would be the first to address speech sound production in infants as young as 7 months of age. We also expect that the screener will be easy to implement clinically and/or in a home setting without SLP support, with little extra training or expense to interpret. The results of this research would have an important ***positive impact*** on caregivers who are seeking early intervention services, as well as clinicians who are trying to determine a child's eligibility for early intervention services.

Clinical Implications

The Speech Sound Development Screener could potentially identify children even younger than is currently common for further assessment and early intervention services, possibly decreasing the time spent in speech/language treatment. Early identification has been linked to decreased time in speech/language therapy (Määttä et al., 2012). Infant speech sounds are produced before first words and are linked with expressive and receptive vocabulary size at 18 months of age (Farnsworth, 2019). Since infants produce speech sounds before spoken words, this could identify children who may be developing atypically without having to wait for them to miss milestones in the typical trajectory for vocabulary development.

Study Limitations and Future Directions

Due to the nature of a master's thesis, some study limitations should be mentioned. The first limitation was the Pocatello Children's Clinic decreased ability to recruit participants as anticipated, due to the outbreak of coronavirus disease (COVID-19). Although this resulted in no research packets being given to caregivers, the potential for future recruitment is still present and can be addressed at a later date. Another limitation was the small sample of caregivers and experts for reviewing the initial draft of the Speech Sound Development Screener. Larger sample

sizes may reveal imperfections in the screener that could have been better addressed. However, many of the experts and caregivers agreed on aspects of organization and content. Expert suggestions were incorporated into the final screener and few experts presented feedback that disagreed with fellow experts. All of the individuals asked to review were known personally or professionally by the researchers, which may influence the feedback they were willing to give. Although there is no indication of bias, there is still a possibility of bias.

Conclusion

Despite these limitations, we were able to create a screening tool that is designed to be used with infants as young as 7 months of age in addressing speech sound production. We would recommend further study of the Speech Sound Development Screener in comparison with results from the CDI-WG (Fenson et al., 2006). Analysis of the Speech Sound Development Screener's validity and reliability is still needed. Future researchers may be able to work with current community partnerships to establish validity. Longitudinal studies for determining reliability of the Speech Sound Development Screener may also be necessary. In the future, the Speech Sound Development Screener could be used to quickly identify infants based on caregiver report for further evaluation by an SLP and potentially decrease the typical age at which children requiring services are identified.

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Appendix A

Idaho State University

Speech Sound Development Screener

Child's Gender: Child's Birthdate: Today's Date:

How often (0-100% of the time) does your child make sounds (throughout the day, in the time that your child is awake, and in the time that you get to spend with your child)?

How often (0-100% of the time)?	Yes or No?	
	Yes No	Does your child cry?
	Yes No	Does your child laugh?
	Yes No	Does your child growl/grunt?
	Yes No	Does your child squeal?
	Yes No	Does your child produce raspberries (sounds like lip trills or balloons deflating)?
	Yes No	Does your child yell?
	Yes No	Does your child whisper?
	Yes No	Does your child produce sounds while playing by himself/herself?
	Yes No	Does your child produce sounds while playing with others (such as parents, siblings, friends, etc.)?
	Yes No	Does your child call to you for attention?
	Yes No	Does your child produce sounds in repetition (such as "ma ma ma ma ma" or "ba ba ba ba ba")?
	Yes No	Does your child imitate speech sounds that you make?
	Yes No	Does your child take turns making speech sounds with you or others, as if participating in a conversation?

	Yes	No	Does your child recognize his/her name?
	Yes	No	Does your child respond to sounds when a source is not visible (perhaps by turning his/her head toward the sound)?
	Yes	No	Does your child use baby signs?

The following is a list of speech sounds babies produce in babbling and first words. Indicate whether or not your child produces each sound. First the sounds have been transcribed using a phonetic alphabet, followed by a description **underlined** in quotation marks. Pay attention to the **underlined** part of the description only when thinking of the sounds your child makes. Do not worry if your child only produces a few of the speech sounds listed because development of speech sounds is variable across children.

	Yes or No?			Yes or No?			Yes or No?	
/bɑ/ as in "**ba**ll"	Yes	No	/nɑ/ as in "**no**t"	Yes	No	/ji/ as in "**yea**r"	Yes	No
/bʌ/ as in "**bu**tt"	Yes	No	/mɑ/ as in "**mo**m"	Yes	No	/ʌm/ as in "**um**"	Yes	No
/bɑɪ̯/ as in "**bye**"	Yes	No	/mʌ/ as in "**mu**tt"	Yes	No	/ʌʔoʊ̯/ as in "**uh oh**"	Yes	No
/bæ/ as in "**ba**t"	Yes	No	/mɑm/ as in "**mom**"	Yes	No	/ɑ/ as in "**to**p"	Yes	No
/dʌ/ as in "**do**ne"	Yes	No	/mæ/ as in "**ma**t"	Yes	No	/ʌ/ as in "**tu**b"	Yes	No
/dɑ/ as in "**do**g"	Yes	No	/wʌ/ as in "**wha**t"	Yes	No	/ɪ/ as in "t**i**p"	Yes	No
/dæ/ as in "**da**d"	Yes	No	/wɑ/ as in "**wa**tt"	Yes	No	/æ/ as in "t**a**p"	Yes	No
/di/ as in "**dee**p"	Yes	No	/pʌ/ as in "**pu**tt"	Yes	No	/ʊ/ as in "t**oo**k"	Yes	No
/hæ/ as in "**ha**t"	Yes	No	/gʌ/ as in "**gu**m"	Yes	No	/u/ as in "t**oo**l"	Yes	No
/hɪ/ as in "**hi**t"	Yes	No	/gɑ/ as in "**go**t"	Yes	No	/i/ as in "t**ea**"	Yes	No
/hʌp/ as in "**hu**p" like "cup"	Yes	No	/gu/ as in "**goo**p"	Yes	No	/ɛ/ as in "t**e**n"	Yes	No
/hɑ/ as in "**ho**t"	Yes	No	/gi/ as in "**gee**k"	Yes	No	/ɝ/ as in "t**ur**n"	Yes	No
/hʌ/ as in "**hu**t"	Yes	No	/kʌ/ as in "**cu**t"	Yes	No	/eɪ̯/ as in "t**a**pe"	Yes	No
/heɪ̯/ as in "**hey**"	Yes	No	/kɑ/ as in "**co**p"	Yes	No	/aɪ̯/ as in "t**ie**"	Yes	No

/haɪ̯/ as in "**hi**"	Yes	No	/tʌ/ as in "**tu**b"	Yes	No	/oʊ̯/ as in "t**oe**"	Yes	No
/næ/ as in "**na**p"	Yes	No	/jʌ/ as in "**yu**m"	Yes	No	OTHER:	Yes	No
/nɛ/ as in "**ne**t"	Yes	No	/jæ/ as in "**yeah**"	Yes	No	/ʘ/ a "kissy" noise	Yes	No
/nʌ/ as in "**nu**t"	Yes	No	/jɑ/ as in "**yaw**n"	Yes	No	/!/ a tongue "click"	Yes	No

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Appendix B

Idaho State University

Speech Sound Development Screener

Child's Gender: Child's Birthdate: Today's Date:

How often (0-100% of the time) does your child make sounds (throughout the day, in the time that your child is awake, and in the time that you get to spend with your child)?

How often? (always, sometimes, never)	Yes or No?	
	Yes No	Does your child cry?
	Yes No	Does your child laugh?
	Yes No	Does your child growl/grunt?
	Yes No	Does your child squeal?
	Yes No	Does your child produce raspberries (sounds like lip trills or balloons deflating)?
	Yes No	Does your child yell?
	Yes No	Does your child whisper?
	Yes No	Does your child produce sounds while playing by himself/herself?
	Yes No	Does your child produce sounds while playing with others (such as parents, siblings, friends, etc.)?
	Yes No	Does your child call to you for attention?
	Yes No	Does your child imitate speech sounds that you make?
	Yes No	Does your child take turns making speech sounds with you or others, as if participating in a conversation?
	Yes No	Does your child produce sounds in repetition (such as "ma ma" or "ba ba")?
	Yes No	Does your child produce advanced babbling (such as "ma be du yah")?
	Yes No	Does your child sometimes sound like they are speaking, but in a different language?
	Yes No	Does your child recognize his/her name?
	Yes No	Does your child respond to sounds when a source is not visible (perhaps by turning his/her head toward the sound)?
	Yes No	Does your child understand simple commands (such as "no" or "sit")?

	Yes	No	Does your child use baby signs?

The following is a list of speech sounds babies produce in babbling and first words. Indicate whether or not your child produces each sound. First the sounds have been transcribed using a phonetic alphabet, followed by a description **underlined** in quotation marks. Pay attention to the **underlined** part of the description only when thinking of the sounds your child makes. Do not worry if your child only produces a few of the speech sounds listed because development of speech sounds is variable across children.

	Yes or No?			Yes or No?			Yes or No?	
/ɑ/ as in "**t<u>o</u>**p"	Yes	No	/ʊ/ as in "t**<u>oo</u>**k"	Yes	No	/ɝ/ as in "t**<u>ur</u>**n"	Yes	No
/ʌ/ as in "**t<u>u</u>**b"	Yes	No	/u/ as in "t**<u>oo</u>**l"	Yes	No	/eɪ̯/ as in "t**<u>a</u>**pe"	Yes	No
/ɪ/ as in "t<u>i</u>p"	Yes	No	/i/ as in "t**<u>ea</u>**"	Yes	No	/aɪ̯/ as in "t**<u>ie</u>**"	Yes	No
/æ/ as in "t**<u>a</u>**p"	Yes	No	/ɛ/ as in "t<u>e</u>n"	Yes	No	/oʊ̯/ as in "t**<u>oe</u>**"	Yes	No
/pɑ/ as in "**<u>pa</u>** pa"	Yes	No	/pi/ as in "**<u>pea</u>**s"	Yes	No	/pu/ as in "**<u>poo</u>**l"	Yes	No
/pʌ/ as in "**<u>pu</u>**tt"	Yes	No	/pæ/ as in "**<u>pa</u>**ss"	Yes	No	/pɪ/ as in "**<u>pi</u>**n"	Yes	No
/bɑ/ as in "**<u>ba</u>**ll"	Yes	No	/bi/ as in "**<u>be</u>**"	Yes	No	/bu/ as in "**<u>boo</u>**"	Yes	No
/bʌ/ as in "**<u>bu</u>**d"	Yes	No	/bæ/ as in "**<u>ba</u>**t"	Yes	No	/bɪ/ as in "**<u>bi</u>**d"	Yes	No
/dɑ/ as in "**<u>do</u>**g"	Yes	No	/di/ as in "**<u>dee</u>**p"	Yes	No	/du/ as in "**<u>do</u>**"	Yes	No
/dʌ/ as in "**<u>do</u>**ne"	Yes	No	/dæ/ as in "**<u>da</u>**d"	Yes	No	/dɪ/ as in "**<u>di</u>**p"	Yes	No
/mɑ/ as in "**<u>mo</u>**m"	Yes	No	/mi/ as in "**<u>me</u>**"	Yes	No	/mu/ as in "**<u>moo</u>**"	Yes	No
/mʌ/ as in "**<u>mu</u>**d"	Yes	No	/mæ/ as in "**<u>ma</u>**t"	Yes	No	/mɪ/ as in "**<u>mi</u>**t"	Yes	No
/nɑ/ as in "**<u>no</u>**t"	Yes	No	/ni/ as in "**<u>knee</u>**"	Yes	No	/nu/ as in "**<u>new</u>**"	Yes	No
/nʌ/ as in "**<u>nu</u>**t"	Yes	No	/næ/ as in "**<u>na</u>**p"	Yes	No	/nɪ/ as in "**<u>kni</u>**t"	Yes	No
/jɑ/ as in "**<u>yaw</u>**n"	Yes	No	/ji/ as in "**<u>yea</u>**r"	Yes	No	/ju/ as in "**<u>you</u>**"	Yes	No
/jʌ/ as in "**<u>yu</u>**m"	Yes	No	/jæ/ as in "**<u>yeah</u>**"	Yes	No	/jɪ/ as in "**<u>yi</u>**ppy"	Yes	No
/wɑ/ as in "**<u>wa</u>**tt"	Yes	No	/wi/ as in "**<u>wee</u>**k"	Yes	No	/wu/ as in "**<u>woo</u>** hoo"	Yes	No
/wʌ/ as in "**<u>wha</u>**t"	Yes	No	/wæ/ as in "**<u>wa</u>**gon"	Yes	No	/wɪ/ as in "**<u>wi</u>**nd"	Yes	No
/hɑ/ as in "**<u>ho</u>**t"	Yes	No	/hi/ as in "**<u>he</u>**"	Yes	No	/hu/ as in "**<u>who</u>**"	Yes	No
/hʌ/ as in "**<u>hu</u>**t"	Yes	No	/hæ/ as in "**<u>ha</u>**t"	Yes	No	/hɪ/ as in "**<u>hi</u>**t"	Yes	No
/tɑ/ as in "**<u>to</u>**p"	Yes	No	/ti/ as in "**<u>tea</u>**"	Yes	No	/tu/ as in "**<u>two</u>**"	Yes	No
/tʌ/ as in "**<u>tu</u>**b"	Yes	No	/kɑ/ as in "**<u>co</u>**p"	Yes	No	/ki/ as in "**<u>key</u>**"	Yes	No
/ku/ as in "**<u>coo</u>**l"	Yes	No	/kʌ/ as in "**<u>cu</u>**t"	Yes	No	/gɑ/ as in "**<u>go</u>**t"	Yes	No
/gi/ as in "**<u>gee</u>**k"	Yes	No	/gu/ as in "**<u>goo</u>**p"	Yes	No	/gʌ/ as in "**<u>gu</u>**m"	Yes	No
/fɑ/ as in "**<u>fo</u>**g"	Yes	No	/fi/ as in "**<u>fee</u>**t"	Yes	No	/fu/ as in "**<u>foo</u>**d"	Yes	No
/fʌ/ as in "**<u>fu</u>**n"	Yes	No	/vɑ/ as in "**<u>vo</u>**lley"	Yes	No	/vi/ as in "**<u>vea</u>**l"	Yes	No
/vu/ as in "**<u>voo</u>**doo"	Yes	No	/ʧɑ/ as in "**<u>cha</u>**lk"	Yes	No	/ʧi/ as in "**<u>chee</u>**k"	Yes	No
/ʧu/ as in "**<u>chew</u>**"	Yes	No	/ʧʌ/ as in "**<u>chu</u>**g"	Yes	No	/ʤɑ/ as in "**<u>jo</u>**b"	Yes	No
/ʤi/ as in "**<u>jee</u>**p"	Yes	No	/ʤu/ as in "**<u>jui</u>**ce"	Yes	No	/ʤʌ/ as in "**<u>ju</u>**g"	Yes	No
/θɑ/ as in "**<u>thaw</u>**"	Yes	No	/θi/ as in "**<u>the</u>**me"	Yes	No	/ði/ as in "**<u>the</u>**se"	Yes	No

/sɑ/ as in "**saw**"	Yes	No	/si/ as in "**see**"	Yes	No	/su/ as in "**sou**p"	Yes	No
/zi/ as in "**ze**bra"	Yes	No	/zu/ as in "**zoo**"	Yes	No	/θðʃɑ/ as in "**jo**b"	Yes	No
/ʤi/ as in "**jee**p"	Yes	No	/ʤu/ as in "**jui**ce"	Yes	No	/rɑ/ as in "**ro**ck"	Yes	No
/ri/ as in "**rea**ch"	Yes	No	/ru/ as in "**roo**m"	Yes	No	/lɑ/ as in "**lo**ck"	Yes	No
/li/ as in "**lea**p"	Yes	No	/lu/ as in "**loo**p"	Yes	No	/ʌm/ as in "**um**"	Yes	No
/ʌʔoʊ̯/ as in "**uh oh**"	Yes	No	/baɪ̯/ as in "**bye**"	Yes	No	/mɑm/ as in "**mom**"	Yes	No
/hʌp/ as in "**hu**p" like "cup"	Yes	No	/heɪ̯/ as in "**hey**"	Yes	No	/haɪ̯/ as in "**hi**"	Yes	No
/ʘ/ a "kissy" noise	Yes	No	/!/ a tongue "click"	Yes	No	OTHER:	Yes	No

References:

Ramsdell-Hudock, H.L., Warlaumont, A.S., Foss, L.E., & Perry, C. (2019). Classification of infant vocalizations by untrained listeners. *Journal of Speech, Language, & Hearing Research, 62,* 3265-3275.

Ramsdell-Hudock, H.L., Stuart, A., & Peterson, T. (2018). What do caregivers tell us about infant babbling? *Studies in Linguistics and Literature. 2*(3). Retrieved from www.scholink.org/ojs/index.php/sll

Farnsworth, A., & Ramsdell-Hudock, H.L. (2019, November). Examining caregiver report of infant vocalizations and later vocabulary ability. Poster presented at the American Speech-Language-Hearing Association Annual Convention, Orlando, FL.

Appendix C

Idaho State University

Family and Infant Background

General Information

Person completing this form (and relationship to child): _____

Date of completion: _____ Infant's date of birth: _____

Primary language spoken at home? _____

Other languages spoken at home? _____

Does your child live with both parents? ☐ Yes ☐ No

With whom does your child spend most of his/her time? _____

_____

_____

Are there any speech, language, or hearing problems in child's immediate family? ☐ Yes ☐ No

If yes, please list family member, relation to child, and problem. _____

_____

_____

_____

Mother

Age at infant's birth: _____ Race: _____

Marital status: ☐ Single ☐ Married ☐ Separated ☐ Divorced ☐ Widowed

Number (and current age) of children: _____

_____

_____

Occupation: _____

Annual income: ☐ Below $25,000 ☐ $26,000-$60,000 ☐ $61,000-$100,000 ☐ Above $100,000

Father

Age at infant's birth: _____ Race: _____

Marital status: ☐ Single ☐ Married ☐ Separated ☐ Divorced ☐ Widowed

Number (and current age) of children: _____

_____

_____

Occupation: _____

Annual income: ☐ Below $25,000 ☐ $26,000-$60,000 ☐ $61,000-$100,000 ☐ Above $100,000

Infant

Sex: ☐ Female ☐ Male

Birthplace: ☐ In state ☐ Out of state ☐ Out of the United States

Length of pregnancy: _____ Length of labor: _____

Type of delivery: ☐ Head first ☐ Feet first (breech) ☐ Caesarian

Birth weight: _____

Were there any unusual conditions that may have affected pregnancy or delivery?

_____

_____

If applicable, provide the approximate ages at which your child experienced the following conditions:

☐ Allergies: _____ ☐ Asthma: _____ ☐ Chicken pox: _____ ☐ Colds: _____

☐ Croup: _____ ☐ Ear infections: ____ ☐ Encephalitis: _____ ☐ Gastroenteritis: _____
☐ Hand-Foot-Mouth: __ ☐ High fever: _____ ☐ Influenza: _____ ☐ Measles: _____
☐ Meningitis: _____ ☐ Mumps: _____ ☐ Roseola: _____ ☐ Pneumonia: _____
☐ Pertussis (Whooping cough): _____ ☐ Respiratory syncytial virus (RSV): _ ☐ Seizures: _____ ☐ Strep Throat: _____
☐ Tonsillitis: _____ ☐ Other: _____

Has your child had any surgeries? ☐Yes ☐ No
If yes, what type and when (e.g., tonsillectomy, tube placement, etc.).

_____
_____

Describe any major accidents or hospitalizations.

_____
_____

Is your child taking medication? ☐Yes ☐ No
If yes, please identify.

_____
_____

Provide the approximate age at which your child began to do the following activities (if your child has begun to do the following activities):

☐ Crawl: _____ ☐ Sit: _____ ☐ Stand: _____ ☐ Walk: _____
☐ Feed self: _____ ☐ Dress self: _____ ☐ Use toilet: _____
☐ Use single words (e.g., no, mom, doggie, etc.) _____
☐ Combine words (e.g., me go, daddy shoe, etc.) _____

Does your child have difficulty walking, running, or participating in other activities that require small or large muscle coordination? ☐ Yes ☐ No
If yes, please describe.

_____
_____

Are there, or have there been any feeding problems (e.g., problems with sucking, swallowing, drooling, chewing, etc.)? ☐ Yes ☐ No
If yes, please describe.

_____
_____

Describe your child's response to sound (e.g., responds to all sounds, responds to loud sounds only, inconsistently responds to sounds, etc.).

_____
_____

Does your child receive special services (e.g., occupational therapy, physical therapy, speech-language therapy, etc.)? ☐ Yes ☐ No
If yes, please describe.

_____
_____

How does your child interact with others (e.g., shy, aggressive, uncooperative, etc.)?

_____
_____

Thank you for your time!

Appendix D
(Parent Letter printed on ISU letterhead)

Dear Caregivers,

We are inviting you to participate in a research study exploring speech development.

Will you fill out the enclosed forms and return them via the stamped/addressed envelope in the next week, to aid in creation of a screener for speech sound development?

Through the College of Rehabilitation and Communication Sciences, researchers at Idaho State University are tracking infant speech sound development. We are creating a screening tool for Speech-Language Pathologists. A screening tool is a simple measure that can be used to determine whether or not children would benefit from additional services.

Right now, there are no screening tools designed to look at the sounds infants make from 7 to 18 months of age. As the most important people in your child's life, you intuitively know a lot about what sounds your child is producing. Your insight can help us create a screener that parents can easily fill out.

If you would like to be contacted by one of the researchers after we review your completed forms, please provide contact information at the bottom of this letter and send it with the packet. Providing contact information is optional and you can participate in the study without providing contact information.

We are excited to have the opportunity to work with caregivers in the Pocatello community, and we welcome questions for further clarification. Questions or concerns can be addressed to Heather L. Ramsdell-Hudock, PhD, CCC-SLP at Idaho State University in the Department of Communication Sciences & Disorders, phone 208-282-3077, email ramsdell@isu.edu.

Sincerely,

Heather L. Ramsdell-Hudock, PhD CCC-SLP

Caregiver Contact Information (Optional)

_____	_____	_____
Caregiver Name (Print)	Phone #	Email

I, _____, consent to be contacted about the information provided in this packet.

Appendix E
(Informed consent printed on ISU letterhead)

Development of a Screening Instrument for Caregiver Report of Infant Speech Patterns

You are being asked to participate in a research study exploring speech development. This research study is in no way related to the services that you will receive at the Pocatello Children's Clinic. Your participation in this research is voluntary. If you decide to participate, you are free to withdraw at any time.

The purpose of this study is to create a screening tool for Speech-Language Pathologists to track infant speech sound development. A screening tool is a simple measure that can be used to determine whether or not children would benefit from additional services. Right now, there are no screening tools designed to look at the sounds infants make from 7 to 18 months of age. As the most important people in your child's life, you intuitively know a lot about what sounds your child is producing. Your insight can help us create a screener that parents can easily fill out.

We are asking that you complete the enclosed forms (related to your child's development) and return them to us via the addressed/stamped envelope in the next week. Completion of the forms should take approximately 30 minutes of your time. We will use the forms to explore patterns in development.

There are no risks to participating in this study. We do not know if you will get any benefits by participating. The benefits to you are mostly the same as the benefits to us. You will be helping us learn about development, and this is a contribution to science.

Please note, if you do not want to take part in this study, you do not have to and your child's care at Pocatello Children's Clinic will not be affected. Anytime that you want to stop participating, that is fine. If you choose to provide your contact information so that we can share screener results, your (your child's) name will not be known and your responses to the study forms will be completely private.

No identifiable information will be documented on test materials. Screener responses will only be viewed by the researchers conducting the study and laboratory staff, all of whom are trained in human subjects and responsible conduct of research. Results will be maintained indefinitely in the research archives of the project, under the supervision of Heather L. Ramsdell-Hudock or her successor(s).

If you have any questions about the research study, please contact Heather L. Ramsdell-Hudock, PhD, CCC-SLP at Idaho State University in the Department of Communication Sciences & Disorders, phone 208-282-3077, email ramsdell@isu.edu. Also, if you have any questions about your rights as a research participant, you may contact the Human Subjects Committee at Idaho State University, phone 208-282-2179.