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Running head: CHILDHOOD SPEECH SOUND DISORDERS IN THE COMMUNITY

Speech Sound Disorders in a Community Study of Preschool Children

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ABSTRACT

Purpose. To undertake a community (non-clinical) study to describe the speech of preschool children identified by parents/teachers as having difficulties "talking and making speech sounds" and compare those who had and had not accessed the services of a speech-language pathologist (SLP).

Method. Stage 1: Parent/teacher concern regarding speech skills of 1,097 4- to 5-year-old children attending early childhood centers was documented. Stage 2a: 143 children identified with concerns were assessed. Stage 2b: Parents returned questionnaires about service access for 109 children.

Results. The majority of the 143 children (86.7%) achieved a standard score below the normal range for the percentage of consonants correct (PCC) on the Diagnostic Evaluation of Articulation and Phonology (Dodd, Crosbie, Holm, & Ozanne, 2002). Consonants produced *incorrectly* were consistent with the late-8 phonemes (Shriberg, 1993). Common phonological patterns were: fricative simplification (82.5%), cluster simplification (49.0%)/reduction (19.6%), gliding (41.3%), and palatal fronting (15.4%). Interdental lisps on /s/ and /z/ were produced by 39.9% of children, dentalization of other sibilants by 17.5%, and lateral lisps by 13.3%. Despite parental/teacher concern, only 41/109 children had contact with an SLP. Children who had contact with an SLP were more likely to be unintelligible to strangers, express distress about their speech, have a lower PCC and a smaller consonant inventory compared to the group who had not contacted an SLP.

Conclusions. There are a significant number of preschool-aged children with SSD who have not had contact with an SLP. These children have mild-severe SSD and would benefit from SLP intervention. Integrated SLP services within early childhood communities would enable earlier identification of SSD and access to intervention to reduce potential educational and social impacts.

Introduction

During the year prior to formal schooling, typically when children are 4- to 5-years-old, fundamental speech and language skills should be mastered (McLeod, 2013; Paul, 2001). At this time, children should be effective oral communicators, readying themselves to transfer these skills to written communication. According to normative studies, preschool children still have a few elements of oral speech and language that have not yet reached adult-like competency, including mastery of some of the late consonants (Smit, Hand, Freilinger, Bernthal, & Bird, 1997), consonant clusters (McLeod & Arciuli, 2009), polysyllabic words (James, 2001; James, van Doorn, McLeod & Esterman, 2008), and grammatical, syntactical, and discourse structures (Paul & Alforde, 1993; Paul & Smith, 1993). However, they should be able to understand and be understood by those with whom they interact in their lives. Children who experience speech sound disorders (SSD) (difficulty with articulation, phonology, motor speech, or Childhood Apraxia of Speech) may have a reduced capacity to interact with others, participate fully in education, and engage in other life activities; and these difficulties many continue into adulthood (Felsenfeld, Broen & McGue, 1992, 1994; Hesketh, 2004; Leitão & Fletcher, 2004; Lewis, Freebairn, Hansen, Iyengar & Taylor, 2004; McCormack, McLeod, McAllister, & Harrison, 2009; Nathan, Stackhouse, Goulandris, & Snowling, 2004a, b; Teverovsky, Bickel, & Feldman, 2009).

In a systematic review of epidemiological studies, Law, Boyle, Harris, Harkness and Nye (2000) indicated the prevalence for SSD to be from 2.3% to 24.6% and for combined speech and/or language disorder to be from 4.56% to 19%. Furthermore, they indicated that children who do not receive intervention, or who begin intervention in the school years, can continue to have difficulties for at least 28 years. Thus, the preschool years are crucial for identifying, assessing and providing intervention to children with communication difficulties (including SSD).

Typically, parents and/or teachers are the first to identify concerns with a child’s ability to communicate. Parental and/or teacher concern often results in referral to speech-language pathology services (Anderson & van der Gaag, 2000); however, this is not always the case (McAllister, McCormack, McLeod, & Harrison, 2011; Tomblin, Records, Buckwalter, Zhang, Smith, & O'Brien, 1997; Zhang & Tomblin, 2000). McAllister et al. (2011) found that many parents who were concerned about their child's speech expected others (particularly teachers, doctors, family, and friends) to confirm their concerns and recommend referral to appropriate services. When others did not recommend referral, many parents did not independently pursue referral even though they remained concerned. Tomblin et al. (1997) found only 29% of children identified as having specific language impairment (SLI) on diagnostic testing had been previously identified with speech and language difficulties. Thus, a gap can exist between the number of children referred to speech-language pathology clinics with speech and/or language concerns, and the number of children in the community who experience speech and language difficulties. It may also be the case that there are associated differences between the communication profiles of the two groups. For example, Zhang and Tomblin (2000) found that children with speech and/or expressive language disorders were more likely to receive SLP intervention than those with receptive language disorders, and that boys were more likely to receive intervention than girls.

Within speech-language pathology clinical practice and research, much of what we know is about "children who have been clinically identified and served" (Tomblin, 2010, p. 108) or about typically developing children who have been part of large-scale normative studies (cf. Dodd, Holm, Hua, & Crosbie, 2003; Goldman & Fristoe, 2000; Smit et al., 1990). The majority of studies that describe children with SSD typically employ a clinical sample (Broomfield & Dodd, 2004a; Flipsen, Hammer & Yost, 2005; Hodson & Paden, 1981; Shriberg & Kwiatkowski, 1982; Shriberg, 1993). For instance, Hodson and Paden (1981) described the phonological processes evident in the speech of unintelligible children (aged 3 to 8 years) who were all receiving or awaiting intervention. They reported differences in the type of processes used and the degree of use in comparison to a group of children with intelligible speech. Shriberg (1993) identified the order in which children with SSD typically acquire consonants (commonly referred to as the early-8, middle-8 and late-8 sounds), based on the accuracy with which the consonants were produced by a group of 64 children with speech delay (aged 3 to 6 years) compared with six normative samples.

While it is important to know about the children within speech-language pathology clinics in order to provide appropriate services for them, Tomblin (2010, p. 108) highlights the "danger" in relying solely on this information. He states, "It is quite possible that not all children with SLI are clinically identified and served within our service delivery systems. In such circumstances, there is the potential for systematic factors to influence which children do or do not find their way to clinical service" (p. 108). In the same way, it is possible that our current knowledge of children with SSD is incomplete. While we have knowledge about typically developing children (that usually excludes children with impairments, cf. Peña, Spaulding & Plante, 2006), and knowledge about children with SSD who are clinically identified and served, it is very likely that there are children within the community who have SSD but are not clinically identified and served.

To investigate the distinction between children who receive services and those who do not, Bishop and McDonald (2009) undertook a comparison of children identified by parental concern and by speech-language pathology testing for SLI. They studied 245 twin children aged 9- to 10-years-old to consider whether children who were referred to a speech-language pathologist (SLP) were the same as those who met test criteria for SLI. They found that parental concern provided different but complementary information to formal speech-language pathology testing. In order to explain the relationship between parental concern and referral to an SLP and identification on speech-language pathology testing, Bishop and McDonald (2009) presented a 2x2 grid of possible scenarios and described the four groups as Quadrants A, B, C, and D in relation to children with speech and language disorders. For the remainder of the paper the different quadrants will be described in relation to children with speech sound disorders and will be accompanied by an abbreviation demonstrating presence (+) or absence (-) of SSD, and contact (+) or no contact (-) with an SLP.

Quadrant A (-SSD-SLP) represents children who are “truly unaffected” (Bishop & McDonald, 2009, p. 602). That is, they are not identified on speech-language pathology testing and are not referred to speech-language pathology services. This quadrant would include most typically-developing children tested within normative studies; for example, the majority of children within the normative study by Smit et al. (1990) although they did include some children “who were receiving intervention for articulation” (p. 780) who would be in quadrant D, below.

Quadrant B (+SSD-SLP) represents children who are “false positives OR true cases unidentified by services” (Bishop & McDonald, 2009, p. 602). That is, these children are identified as having SSD during testing but have not attended speech-language pathology services. These are the children who “do not find their way to clinical service” (Tomblin, 2010, p. 108), and are the main focus of the current paper.

Quadrant C (-SSD+SLP) represents “over concern OR resolved problem OR problem missed by diagnostic method” (Bishop & McDonald, 2009, p. 602). That is, these children are referred to speech-language pathology services, but are not identified as having SSD during speech-language pathology testing. For instance, in a study by Keegstra, Knijff, Post, and Goorhuis-Brouwer (2007), 35% of preschool children referred to speech-language pathology services in the Netherlands were found to have adequate speech and language skills.

Quadrant D (+SSD+SLP) represents children who are “truly affected” (Bishop & McDonald, 2009, p. 602). That is, they are identified as having SSD on speech-language pathology testing and have been referred to/ are receiving speech-language pathology services.

Knowledge about children with SSD primarily is based on studies of typical communication development in children who are truly unaffected (quadrant A: -SSD-SLP) and studies of clinical samples of children with an identified SSD (i.e., those who are truly affected, in quadrant D: +SSD+SLP). There is less knowledge about children whose SSD may have resolved or were not identified on speech-language pathology assessment (quadrant C: -SSD+SLP). The group that is rarely considered within the speech-language pathology literature is children who have not been referred to SLPs, but who present with SSD when tested (quadrant B: +SSD-SLP). Investigating and describing the nature and severity of SSD in children within the general community provides an opportunity to examine the development and characteristics of disorder in children who currently may not have a diagnosis. Such information is important for identification of SSD and delivery of appropriate and timely intervention. Examining differences in children who access and do not access SLP services is important for providing insight into the speech characteristics of children that result in referral and access to appropriate services.

Unique Context and Aims of the Current Research

The Australian prior-to-school context provides an ideal condition for consideration of the nature and severity of childhood SSD in the community. Within Australia, almost all (96.3%) Australian 4- to 5-year-old children attend child care or an early education program in preschool or school (Harrison et al., 2009). However, there is no systematic speech and language screening in these prior-to-school or school settings, and no laws mandating that children receive speech-language pathology services (McLeod, Press & Phelan, 2010). Thus, the first aim of this study was to undertake a community (non-clinical) study to identify and describe SSD in 4- to 5-year-old children identified by parents/teachers as having difficulties “talking and making speech sounds”. A second aim was to differentiate speech characteristics of the sample of children who had been assessed as having typical speech (-SSD+SLP and -SSD-SLP) versus those assessed as having SSD who either were “true cases unidentified by services” (+SSD-SLP) or “truly affected” and attending speech-language pathology services (+SSD+SLP).

Method

Participants

Recruitment of 4- to 5-year-old children.

Prior-to-school early childhood settings (preschools and childcare centers) were the recruitment sites for the study sample. Metropolitan, regional and rural locations in the two most populated states of Australia, New South Wales (NSW) and Victoria (VIC), were identified in order to access a sample that was representative of Australia's geographical diversity. Locations in each state were matched on the basis of population, remoteness of town and accessibility to services as defined by the Accessibility/ Remoteness Index of Australia (Department of Health and Aged Care, 2001). Details for preschools and childcare centers operating in each location were collected via information provided by local government or key stakeholder organisations and by published listings. Each center was contacted and provided with information detailing the purpose and procedure of the study. A total of 33 centers agreed to participate in the study and children who were assessed in stage 2 came from 32 centers. Of these, 15 were located in metropolitan areas (capital cities with populations > 1 million), 10 in large regional cities (population between 50,000 –100,000), 5 in small regional towns (population between 10,000 – 50,000), and 2 in rural towns (population < 5,000) (Department of Health and Aged Care, 2001). Figure 1 provides a summary of the recruitment, assessment and categorization of children according to Bishop and McDonald's (2009) four quadrants.

Insert Figure 1 here

Screening of 4- to 5-year-old children.

Participating teachers were asked to complete a brief screening questionnaire for each child in their class who was aged between 4 and 5 years. Parents were also asked (by their child's teacher) to complete a similar questionnaire. Teacher and/or parent information was returned for 1,097 children, of whom 616 (56.3%) were male and 473 (42.9%) were female (data were not available for 8 children) [1]. The average age was 56.5 months (*SD* = 5.6 months; range = 39 to 76 months) (age data were not available for 47 children). The majority of children (96.2%) were between 48 and 70 months. Screening for SSD was based on one question from the Parent's Evaluation of Developmental Status (Glascoe, 2000) that asked whether the teacher or parent had concerns about how the child "talks and makes speech sounds".

Teacher responses were provided for 1,041 children: 704 (69.9%) of whom received a response of "no concern" and 324 (31.1%) who received a response of "yes" or "a little" concern. Parents responses were provided for 460 children: 259 (56.3%) of whom received a response of "no concern" and 201 (43.7%) who received a response of "yes" or "a little" concern. By combining parent and teacher responses to the Parent's Evaluation of Developmental Status, a potential sample of 386 children with parent/teacher concerns was identified. Parents of these children were offered a direct assessment of their child's speech and invited to participate in stage 2 of the study (a comprehensive communication assessment by an SLP).

Parental consent was provided for 208 children, with 143 receiving an assessment. Of the 143 children, there were 79 (55.2%) identified both by their parent and teacher as having "difficulty talking and making speech sounds," 54 (37.8%) identified only by their parent and 10 (7.0%) only by their teacher. The 65 children who did not receive an assessment were either unable to be contacted (n = 18), not able to attend the assessment (e.g., due to ill health) (n = 11), had a concomitant diagnosis, such as cleft palate (n = 16), were outside the age range (n = 3), or their parents either did not return the consent form (n = 11) or were no longer concerned (n = 6).

Characteristics of the identified sample of children with parent/teacher concern.

[1] The proportion of boys to girls (1.31:1) is considerably higher than in the Australian population of 4- to 5-year-olds attending preschool services (1.05:1) (Harrison et al., 2009). Our information about the number of 4- to 5-year-olds in the sites was based on the number of children for whom screening forms were returned, but we had no independent means to count the actual number of boys and girls in that age range at each site. It is possible that respondents chose to fill out more screening forms for boys than for girls.

Demographic characteristics. The 143 identified children were called the Sound Effects Study sample. The sample comprised 96 (67.1%) males and 47 (32.9%) females, with an average age of 55.1 months (*SD* = 5.0, range = 47 to 70 months). The majority of children were single births (105, 96.3%) and were in households with at least two children (104, 95.4%). Children were equally distributed across two Australian states: 68 in VIC and 75 in NSW, with 74 (51.7%) living in a principal urban center, 35 (24.5%) in a large regional city, 24 (16.8%) in a small regional town, and 10 (7.0%) in a small rural town. Most children lived in areas of mid-high socio-economic status; however, 10 children (6.4%) lived in areas of relative disadvantage (below the 30th percentile), as measured by the Index of Relative Socioeconomic Advantage and Disadvantage (Australian Bureau of Statistics, 2008).

Speech characteristics. Parents were asked to provide additional background and developmental information about the child. Information was provided for 109 children (34 parents did not return the questionnaire). Parents confirmed that none of the children had been diagnosed with cognitive difficulties, other developmental disorders, or oral structural impairments (e.g., cleft lip or palate). Twenty-four (23.8%) of the children were identified as “late talking” by their parents. The majority (57, 60.0%) began to babble before 6 months and said their first word either before 12 months (48, 48.0%) or between 12 and 18 months of age (44, 44.0%). A number of children’s relatives had a history of speech, language, literacy or hearing difficulties: 24 (27.9%) had cousin(s), 21 (28.4%) had brother(s), 14 (16.5%) had uncle(s), 12 (14.6%) had sister(s), 11 (11.5%) had a father, and 10 (10.1%) had a mother with a history of communication difficulties. All children spoke English as their first language. Only 4 children (from the 109 with available data) spoke another language as well as English. Those languages were Spanish, Serbian, German and Italian.

Receptive and expressive language, hearing, oromotor, voice, fluency, pre-literacy, and phonological awareness abilities were assessed for all 143 children and characteristics are detailed in the Appendix. Results showed that some of the children had concomitant communication impairments.

Of note, there were 52 (43%) children who did not pass the hearing screening assessment in at least one ear for at least one frequency (1000, 2000, and 4000Hz). Background noise during hearing screening was inevitable since screening was undertaken within childcare centers, and that may have increased the number of children who failed. These children were referred for comprehensive audiological assessment; however, results of these assessments were not available to the researchers. None of the children wore hearing aids or had cochlear implants; however, teachers reported that 9 (6.4%) children had ongoing hearing problems and parents reported that 12 (9.0%) children had ongoing hearing problems.

***Representativeness of the identified sample compared with Australian children*.**

In order to assess the representativeness of the identified sample, characteristics of the 143 children and their families from the Sound Effects Study were compared with data reported for the Kindergarten cohort of the Longitudinal Study of Australian Children (LSAC) (McLeod & Harrison, 2009). The LSAC cohort comprised a nationally representative sample of 4,983 4- to 5-year-olds, of whom 3,914 had not yet started school and were attending preschools or childcare centers. Based on parent reports for the Parent's Evaluation of Developmental Status screening item, 999 (25.5%) of children in the LSAC sample were identified with parental concerns about how they "talked and made speech sounds". This group (n = 999) formed the comparison sample for the Sound Effects Study (n = 143). Demographic characteristics for the present study and the comparison sample are presented in Table 1. Figures for child characteristics (number of boys and girls, average age, Indigenous status, number of older and younger siblings) were similar across the two groups. There were differences on other measures; however, these did not indicate major discrepancies from the LSAC sample. Comparatively fewer children in the Sound Effects Study were exposed to a language other than English at home (9.3% vs. 15.0%). Family demographics (mothers' and fathers' education, family income) and community indices suggested that children in the Sound Effects Study were somewhat more advantaged, on average, than those in the LSAC sample.

Insert Table 1 here

Speech Assessment Instruments

Speech instruments.

Speech was primarily assessed using the Articulation and the Phonology subtests from the Diagnostic Evaluation of Articulation and Phonology (DEAP) (Dodd Crosbie, Holm, & Ozanne, 2002). The DEAP Phonology subtest was selected as it provided normative data for Australian and British children. When combined with the Articulation subtest, it enabled a comprehensive sampling of a broad range of phonemes (consonants, vowels, and consonant clusters) in a range of contexts and syllable shapes including polysyllabic words. In the results section that follows, the normative data is based on the children's scores from the Phonology subtest; however, the subsequent description of the children's speech characteristics presents their performance on both the Articulation and Phonology subtests in order to present a larger number of the children's productions. Additionally the four domains relating to the Speech scale from the Australian Therapy Outcome Measures for Speech Pathology (AusTOMs, Perry & Skeat, 2004) were used to describe the children's speech impairment, activity limitation, participation restriction, and distress. These domains have six levels ranging from 5 = *no difficulty* to 0 = *profound difficulty*.

Intelligibility instruments.

Intelligibility was assessed using two measures. The first was the Intelligibility in Context Scale (McLeod, Harrison, & McCormack, 2012), a parent-report scale of children's intelligibility in seven different contexts: with the parents themselves, immediate family members, extended family members, teachers, friends, acquaintances and strangers. The second measure was an adaptation of the Intelligibility Index (Flipsen, 2006) where the number of intelligible words identified by the transcriber was calculated from a connected speech sample obtained via children retelling the Bus Story (Renfrew, 1997b).

Parent Questionnaire

The 77-item parent questionnaire requested information about aspects such as their children's health, speech, and language development, and families' access to a range of services. It included three questions about their child's contact with an SLP: "Has your child ever had a speech-language pathology assessment?" "Has your child ever had speech-language pathology intervention?" "Does your child currently receive speech-language therapy?" Information was provided for 109 children (34 parents did not return the questionnaire).

Procedure

SLP assessment.

All of the communication assessments were conducted by the same SLP (the fourth author), who was an experienced pediatric clinician. Assessments took place in a quiet room in the early childhood center that the child attended, with the consent of parents and the assent of children (cf. Harcourt & Conroy, 2005). Children were accompanied by a familiar adult, usually a parent. The assessment took approximately 1 – 1½ hours to complete and took place over 1 to 2 sessions, depending on the child's concentration level. When a second assessment session was required, this typically took place in the main room of the childcare center in the absence of the parent (although a center staff member was present). The second assessment session typically was conducted within a week of the first assessment session; however, for 14 participants, the second assessment session was completed within 3 months of the first. Assessments were audio-recorded using a Sony MP3 digital recorder (ICD-UX80) with in-built microphone. During administration of the DEAP (Dodd et al., 2002), the SLP transcribed the child's responses online using broad transcription. The SLP re-listened to the speech assessment within 24 hours of the session to check transcription. Parents were given the 77 item parent questionnaire prior to the assessment, and were asked to bring the completed form to the assessment. Parents were encouraged to return the questionnaire by post if it had not been completed by the end of the assessment session. The AusTOMs was scored immediately following each assessment. The SLP based the AusTOMs ratings on direct assessment of the child, discussions with the child, parent, and teacher, and the parent questionnaire.

Reliability

Reliability of speech transcription was calculated using the point-to-point agreement (consonants and vowels) for on-line transcription of each item on the DEAP Articulation and Phonology subtests. Intra-rater reliability was determined after the SLP re-transcribed 10% of the participants' DEAP Articulation and Phonology subtests 6 months after the original assessment. The intra-rater reliability measure for the transcription of the participants' speech samples (comprising a total of 3517 phonemes) was high (mean = 93.65%; range = 84.33 – 97.49). Inter-rater reliability was also determined for 11 different participants by two qualified SLPs who were present during different assessments: the SLP plus one reliability judge provided data for 6 participants and the SLP plus the other reliability judge provided data for another five participants. The inter-rater reliability for the transcription of 11 participants' speech samples (comprising a total of 3594 phonemes) was also high (mean = 91.94%; range = 86.50 – 96.95), indicating an acceptable level of reliability for speech transcription. In addition, one of the reliability judges also scored the AusTOMs for 6 of the participants. Inter-rater reliability was calculated for each of the items on the AusTOMs measure, again with high overall agreement (91.7%). The original SLP's transcriptions and scores were used in the subsequent data analysis.

Data Analysis

Each child's responses to items on the DEAP (Articulation and Phonology subtests) were entered into Computerized Profiling (PROPH+; Long, Fey & Channell, 2006). Each PROPH+ output was individually checked for errors. This involved checking for words classed as "problems" by the program due to syllable structure changes (e.g., *umbrella* → *brella* or *fish* → *fishy*) and adding these to the consonant and vowel target analysis and the phonological process analysis. The PROPH+ category of "Other substitutions and distortions" was checked for words that could be categorized under specific phonological processes. Occasionally words were included in this category when more than one phonological process was produced (e.g., *pram* → *bwam*), so these words were added to the appropriate categories (in this case, voicing and gliding). Words in which the children had produced an interdental lisp were also included by PROPH+ in this "other" category, so a separate category was created and the number of interdentalized and dentalized sibilants was calculated. The accuracy of categorization for all other words in the phonological patterns was also checked. When checking was complete, the analyses of consonants, vowels, phonological processes, and substitution, omissions, distortions and additions (SODA) were then recalculated to determine the number of opportunities, and number of correct productions (consonants and vowels) or number of occurrences (phonological processes). Results from the PROPH+ analysis as well as raw and standard scores from the speech assessments were entered into the Statistical Program for the Social Sciences (SPSS) Version 17.0.2 computer program (PASW Statistics, 2009) and analysed using descriptive statistics, analysis of variance (ANOVA) and chi-square (χ^2) statistical tests for group comparisons. The non-overlap of 95% confidence intervals was included as a further check for group differences.

Results

Speech Characteristics of Children in the Sound Effects Study Sample

The first aim of this study was to determine the speech characteristics of a sample of 4- to 5-year-old children whose parents/teachers were concerned about how they "talked and made speech sounds." All of the 143 children who participated in the communication assessments had been identified by parents and/or teachers with concerns about their ability to "talk and make speech sounds." The majority of the children (124, 86.7%) achieved a standard score at least one standard deviation below the mean for the percentage of consonants correct (PCC) on the DEAP (Dodd et al.,

2002) and 93 (65.0%) were at least two standard deviations below the mean. For the purposes of the present study, 124 children were identified as having SSD. Additional information regarding the speech characteristics of the 143 children are described later.

The second aim was to differentiate speech characteristics of the children based on their diagnosis of SSD and their contact with an SLP, and specifically to describe children who were "true cases unidentified by services" (quadrant B: +SSD-SLP, Bishop & McDonald, 2009, p. 602). Parent information (n=109) regarding utilization of speech-language pathology services indicated that 41 (37.6%) children had accessed speech-language pathology services, while 68 (62.4%) children had not had contact with an SLP. Thus, these 109 children were divided within the four quadrants described by Bishop and McDonald (2009) (Table 2).

- *Quadrant A* (-SSD-SLP) "Truly unaffected." There were 12 children (11.0%) whose PCC performance on the DEAP placed them within normal limits for speech development and who had not had contact with an SLP.
- *Quadrant B* (+SSD-SLP) "False positive or true cases unidentified by services." There were 56 (51.4%) children whose performance on the DEAP placed them at least one standard deviation below the mean, and who had not had contact with an SLP. This group is rarely addressed in speech-language pathology literature, yet there were more children in this quadrant than the others.
- *Quadrant C* (-SSD+SLP) "Overconcern, or resolved problem, or missed by diagnostic method." There were 6 (5.5%) children whose performance on the DEAP placed them within normal limits for speech development who had accessed speech-language pathology services. Due to the small numbers in this group they were combined with the -SSD-SLP group for further analyses, creating a group identified as having speech skills that were within normal limits. This group is identified as -SSD±SLP.
- *Quadrant D* (+SSD+SLP) "Truly affected." There were 35 children (32.1%) whose performance on

the DEAP placed them at least one standard deviation below the mean, and whose parents had accessed speech-language pathology services.

In order to address the second aim of this study, speech characteristics for three groups (-SSD±SLP, +SSD-SLP, and +SSD+SLP) are described and compared in the following sections.

Insert Table 2 here

Speech of Children in the Sound Effects Study Sample

Independent analysis of speech sample

Number of consonants, consonant clusters, and vowels.

Total sample. The number of consonants, consonant clusters, and vowels each child produced was calculated (regardless of whether they matched the adult target). The 143 children produced an average of 19.10 consonants (*SD* = 1.86; range = 10-23), 19.81 consonant clusters (*SD* = 5.56; range = 1-27) and an average of 19.62 vowels and diphthongs (*SD* = 0.70; range = 16-21) (see Table 3).

Insert Table 3

Differences among groups. Group comparisons using ANOVA tests (Table 3) indicated a significant difference among the three groups of children (-SSD±SLP vs. +SSD-SLP vs. +SSD+SLP) for consonants, clusters, and total inventory. In each case, the number of speech sounds produced by children in the -SSD±SLP group was higher than the +SSD groups (+SSD-SLP and +SSD+SLP). When children in the +SSD groups were compared (Table 3), consonant production was higher for children in the +SSD-SLP group compared to the +SSD+SLP group. This finding suggests a difference in the speech skills of children with identified SSD who have had contact with an SLP and those who have not.

Relational analysis of speech sample

Percentage of consonants, vowels, and phonemes correct.

Total sample. Three standard measures were extracted from children’s productions on the

Phonology subtest of the DEAP: percentage of consonants correct (PCC), percentage of vowels correct (PVC), and percentage of phonemes correct (PPC) (Shriberg & Kwiatkowski, 1982; Shriberg, Kwiatkowski, Best, Hengst & Terselic-Weber, 1986). The children's scores were calculated using the protocols as described in the DEAP manual (Dodd et al., 2002) so that their results could be compared with the normative data provided in the DEAP manual (see Table 4). The children's average PCC was 68.09 (*SD* = 14.31; range = 17.9 – 96.4) with 124 (86.7%) achieving a standard score greater than one standard deviation below the mean, which is below the range of typical performance. The children's average PVC was 95.47 (*SD* = 5.20; range = 62.80 – 100.00) with 88 (61.5%) achieving a standard score below the range of typical performance. Children's average PPC was 77.96 (*SD* = 10.48; range = 38.01 – 97.70) with 127 children (88.8%) achieving a standard score below the range of typical performance. Of these, 115 (80.4%) scored more than two or more standard deviations below the mean (Table 4).

The children were most often correct in their production of nasals (mean percentage correct = 96.39), stops (mean percentage correct = 89.88), and glides (mean percentage correct = 80.94). Consonant clusters posed the greatest difficulty (mean percentage correct = 39.97) (see Table 5).

Insert Tables 4 and 5 here

Differences among groups. Group comparisons indicated a significant difference among the three groups of children (-SSD±SLP vs. +SSD-SLP vs. +SSD+SLP) for all three phonology subtests of the DEAP. In each case, the scores for children in the -SSD±SLP group were higher than the +SSD groups (+SSD-SLP and +SSD+SLP) (Table 5).When the children in the +SSD-SLP and +SSD+SLP groups were compared, there were significant differences for PCC and PPC, again with +SSD-SLP achieving higher scores than +SSD+SLP, but no difference for PVC. These results suggest there may be a quantifiable difference in the severity of SSD for children who have and have not had contact with an SLP.

Results presented in Table 5 also show significant differences among the three groups of children for five of the eight classes of speech sounds. In each case, the children in the -SSD±SLP group obtained the highest percentages correct, followed by the +SSD-SLP group, with the lowest scores being achieved by children in the +SSD+SLP group. Comparison tests were significant for percentage of fricatives, affricates, liquids, clusters and cluster elements produced correctly. Furthermore, when children in the +SSD-SLP and +SSD+SLP groups were compared, results achieved significance ($p < .05$) for percentage of liquids and consonant cluster elements correct and approached significance ($p < .10$) for percentage of fricatives correct, with those in the +SSD-SLP group achieving higher scores than those in the +SSD+SLP group.

Articulation Competence Index (ACI).

Total sample. The ACI (Shriberg, 1993) was calculated using two characteristics of speech: the percentage of consonants produced correctly and the percentage of all consonants produced incorrectly due to articulatory distortions (Shriberg, 1993). A lower ACI is indicative of greater speech difficulty due to more consonants in error. On average, children typically presented with a low ACI (mean = 36.63, *SD* = 10.39), although this ranged from 10.20 to 96.00 (see Table 5).

Differences among groups. There was a significant difference in ACI across the three groups with children in the -SSD±SLP group achieving a higher score than those in the +SSD-SLP and +SSD+SLP groups. Results of the comparison between the +SSD-SLP and +SSD+SLP groups approached significance ($p < .10$), again with the +SSD-SLP group achieving a higher ACI than the +SSD+SLP group. This suggests that those who had contact with an SLP had greater speech difficulty than those who did not have contact.

Severity index.

Total sample. The severity index (Shriberg et al., 1986) was calculated by PROPH+ based on the children's PCC from productions of words on the Phonology subtests of the DEAP (Dodd et al., 2002). It is noted that the severity index was originally developed by Shriberg et al. (1986) for application to connected speech samples. However, it was considered a useful guide for evaluating the severity of disorders experienced by the children in this sample. Thirteen (9.1%) of the 143 children were classified as severe, 40 (28.0%) as moderate-severe, 75 (52.4%) as mild-moderate, and 15 (10.5%) as having mild SSD.

Differences among groups. Group comparisons using chi-square test indicated that the distribution of severity was significantly different across the three groups of children: χ^2 (6,109) = 44.99, p < ,01. Children in the -SSD±SLP group were classified as either mild (55.6%) or mild-moderate (44.4%), whereas children in the +SSD-SLP group tended to be classified as mild-moderate (66.1%) or moderate-severe (23.2%) and children in the +SSD+SLP group were equally likely to be classified mild-moderate (49.2%) or moderate-severe (40.0%). The +SSD+SLP group had the highest proportion of children classified as having severe SSD (14.3%).

Accuracy of consonant, vowel, and diphthong productions.

Total sample. The children's accuracy of consonant production was determined by using PROPH+ to analyse the speech sample generated from the DEAP Articulation and Phonology Subtests. Children's productions of consonants were categorized as either incorrect, marginal (sometimes correct/ insufficient sample), or correct at all times (see Table 6). The majority of children frequently produced the following consonants *incorrectly*: /θ/ (76.2% of children produced /θ/ incorrectly), /ð/ (55.9%), and /ɹ/ (54.5%). Other consonants frequently produced incorrectly were /z/ (30.8% of children), /ʃ/ (25.2%), /s/ (23.1%), /ʧ/ (21.7%), and /ʤ/ (18.9%). The majority of children frequently produced the following consonants *correctly*: /w/ (94.4% of children produced /w/ correctly), /m/ (88.8%), /h/ (88.8%), /ŋ/ (88.8%), /b/ (85.3%), /n/ (85.3%), /p/ (83.2%), /d/ (81.1%), /f/ (72.7%), /g/ (71.3%), /k/ (62.9%), and /j/ (51.0%).

All vowels and diphthongs were produced *correctly* by the majority of children, with the mean percentage correct ranging from 90.6% for /ə/ to 100.0% for the dipthong /εə/ (in words such as *hair*, *bear*, since Australian-English does not have post-vocalic /ɹ/) (see Table 7). There were few vowels and diphthongs consistently produced *incorrectly* by any children: /ɔɪ/ (3.5% of children), /aʊ/ and /ɪə/ (2.8%), and /eɪ/ (1.4%). However, for some vowels and diphthongs, there was a high proportion of marginally correct productions: /ɜ/ (75.5% of children), /ə/ (55.9%), /ε/ (44.8%), and /æ/ (28.0%). Marginal productions were coded when there was inconsistency in productions, or insufficient exemplars.

Insert Tables 6 and 7 here

Occurrence of lisps.

Total sample. There were a total of 57 (39.9%) children who used interdental lisps: 31 (21.7%) children frequently produced interdental lisps (>40% of the available exemplars per child), and 26 (18.2%) children infrequently produced interdental lisps (<40% of the available exemplars). Interdental lisps were produced for 19.1% of all /s, z/ consonants by the 143 preschool children (*SD* = 31.9, range = 0.0-100.0%). Dentalization of the sibilants /ʃ, ʒ, ʧ, ʤ/ was produced by 25 children (17.5%), lateral lisps on /s, z, ʃ, ʒ, ʧ, ʤ/ were produced by 19 children (13.3%), palatal lisps on /s, z/ were produced by 9 children (6.3%).

Differences among groups. There was no significant difference among children in the three groups regarding the frequency of production of lisps.

Substitution/Omission/Distortion/Addition (SODA) error analysis.

Total sample. A SODA analysis was undertaken on the children's productions on the DEAP Articulation and Phonology Subtests (see Table 5). The majority of errors were substitutions (mean =

77.5, *SD* = 14.2). Omissions of parts of the consonant cluster were the next most frequent (mean = 11.2, *SD* = 8.7), followed by omissions of singletons (mean = 5.1, *SD* = 5.4). Omissions of all elements of the consonant cluster were rare, as were distortions and additions.

Differences among groups. Group comparisons using ANOVA tests (Table 5) indicated a significant difference among children in the -SSD±SLP, +SSD-SLP and +SSD+SLP groups for substitutions, but no difference between the +SSD-SLP and +SSD+SLP groups. Children in the -SSD±SLP group produced a significantly higher proportion of substitutions (compared to other errors) than those in the +SSD-SLP and +SSD+SLP groups.

Whole word and word shape measures.

Total sample. The children produced an average phonological Mean Length of Utterance (pMLU, Ingram & Ingram, 2001) of 5.54 (*SD* = 0.49) (see Table 5). Their average maximum pMLU was 6.46 (*SD* = 0.51) and average whole word proximity score was 85.89 (*SD* = 7.62). The average scores for total word shape match (e.g., CVC = CVC) and stress pattern match (e.g., strong weak = strong weak) for mono- and polysyllabic words were high, although there was some variability within groups.

Differences among groups. Group comparisons for the three groups of children showed a significant difference for all word matches (shape and stress). Children in the -SSD±SLP group achieved higher scores, while there was no difference between the scores achieved by children in the +SSD-SLP and +SSD+SLP groups.

Phonological processes usage.

Total sample. The most frequent phonological processes produced by the 143 children were fricative simplification (82.5% of children used the process in > 40% of the available exemplars), liquid deletion (in word-final position) (79.0%), cluster simplification (49.0%) and gliding (41.3%) (see Table 8). Other phonological patterns that were present in children's speech less frequently (i.e., less than 40% of the available exemplars per child) were: later stopping (substitution of a plosive for a later-developing fricative, such as /θ/ or /ð/) (87.4% of children used the pattern sometimes), cluster reduction (70.6%), voicing (67.1%), final consonant deletion (60.8%) and syllable structure deletions (58.0%).

Differences among groups. Group comparisons using ANOVA tests for the three groups of children showed a significant difference in the use of cluster simplification, gliding, cluster reduction, palatal fronting, and later stopping. In addition, there was a significant difference in the use of liquid deletion (in word-final position) and gliding between those in the +SSD-SLP and +SSD+SLP groups.

Intelligibility

Intelligibility in Context Scale.

Total sample. Parents were asked to complete the Intelligibility in Context Scale (McLeod et al., 2012) based on their child's speech over the past month (see Table 9) to identify how well their child was understood by a range of communication partners. The Intelligibility in Context Scale uses a 5-point Likert scale, from 5 = always understood to 1= never understood. Data were available for 109 children whose parents completed this task. Parents' ratings indicated that *they* were most likely to understand their child (mean = 4.3; *SD* = 0.6) followed by *immediate members of their family* (mean = 4.1; *SD* = 0.6), *teachers* (mean = 4.0; *SD* = 0.5) and *extended family members* (mean = 3.8; *SD* = 0.7). *Strangers* were least likely to understand their child (mean = 3.4; *SD* = 0.7).

Insert Table 9 here

Differences among groups. Group comparisons (Table 9) indicated a significant difference among the three groups of children for four of the seven items in the Intelligibility in Context Scale: parent self-ratings of their ability to understand their child, their ratings of immediate family members, extended family members and strangers. There was also a significant difference in the degree to which parents of children in the +SSD-SLP and +SSD+SLP groups rated strangers' ability to understand their child, with children in the +SSD+SLP group receiving the lowest ratings.

Number of intelligible words on story retell

Total sample. A measure of the children's intelligibility was calculated from the connected speech sample generated from the retelling of the Bus Story (Renfrew, 1997b). An adaptation of the Intelligibility Index (Flipsen, 2006) was calculated for 137 children by dividing the number of intelligible words by the total number of words. Data were unavailable for six children who had refused to complete this task. For the 137 children, the average number of words within the samples was 94.6 (*SD* = 38.4, range = 16-217). The mean number of intelligible words was 95.5% (*SD* = 5.6, range 65-100%) (see Table 5).

Differences among groups. There was no significant difference in the proportion of intelligible words produced by children in the three groups.

Functional Outcomes

Total sample. The four domains from the Speech scale of the AusTOMs (Skeat & Perry, 2004) were completed by the SLP who assessed the children in order to consider the broader impact of SSD on the children's health and wellbeing. For each scale a score of 0-4.5 was considered as indicating an area of difficulty/concern. On the Speech Impairment scale, 124 (86.7%) children were identified with at least some Speech Impairment (mean = 4.0, *SD* = 0.7). On the Speech Activity Limitation scale, 80 (55.9%) children were identified with at least some limitation (mean = 4.4, *SD* = 0.7). On the Speech Participation Restriction scale, 56 (39.2%) children were identified with at least some restriction (mean = 4.6, *SD* = 0.6), range = 2.5-5). Finally, on the Speech Distress scale, 43 (30.1%) children were identified with at least some distress (mean = 4.7, *SD* = 0.5).

Differences among groups. Group comparisons indicated a significant difference among the three groups of children for all four subscales, with children in the -SSD±SLP group receiving consistently higher (i.e., less affected) scores than children in the +SSD-SLP and +SSD+SLP groups.

However, only the Speech Distress scale showed a significant difference between children in the +SSD-SLP and +SSD+SLP groups. This suggests a difference in the perceived impact of SSD on the life activities and social-emotional wellbeing of the children. The difference in Speech Distress scores across the +SSD-SLP and +SSD+SLP groups may reflect a contributing factor in parents' decision regarding whether to seek assistance for their child's SSD.

Discussion

The majority of research within the speech-language pathology profession has been undertaken with clinical or normative samples. However, such research excludes individuals with SSD who are not currently part of a clinical caseload and may never have received an assessment or intervention (+SSD-SLP); that is, children classified by Bishop and McDonald (2009, p. 602) as "false positives or true cases unidentified by services". Failure to consider this population has implications for SLPs' knowledge of the characteristics of different disorders, for service planning, and for understanding factors that result in individuals seeking and/or receiving services.

SSD in a Sample of Children whose Parents and/or Teachers are Concerned

The first contribution of the current study is that it presents an overview of the speech skills of a community-based study of children whose parents and teachers are concerned about how they "talk and make speech sounds." Children in this sample could produce approximately 80% of the 24 Australian English consonants (average of 19.10). Additionally, they could produce almost all (average of 19.62) of the 20 Australian English vowels (12-13 monophthongs and 7-8 diphthongs) (Cox, 2008; McLeod, 2007). However, the children in the current study demonstrated varying levels of severity and intelligibility.

Overall, the speech skills of the community-based sample of children were similar to clinical samples described within other research studies. For example, the consonants most frequently produced correctly were /w/, /m/, /h/, /ŋ/, /b/, /n/, /p/, /d/, /f/, /ɡ/, /k/ and /j/. The acquisition of these consonants followed a similar pattern to that proposed by Shriberg (1993). Indeed, seven of the eight consonants consistently produced *correctly* by children in the present study were within the group of early-8 sounds. The only difference was with the classification of /j/ and /ŋ/. Shriberg (1993) classified /j/ as an early sound, but it appeared later in this study. The effect of the target word could explain this discrepancy. /j/ was sampled twice in the DEAP assessment, both in the word *yellow*; a word that is prone to the coarticulatory effects of /l/; typically resulting in the production of *lellow*. It is possible that other words commencing with /j/ may have been more likely to result in a correct production. Shriberg classified /ŋ/ as a middle sound, yet it appeared earlier in the current study. The acquisition of /ŋ/ is in accord with normative studies of Australian English show that it is typically acquired by 2;6 (Chirlian & Sharpley, 1982) or 3;0 (Kilminster & Laird, 1978).

In the present study, the consonants most frequently produced *incorrectly* were /θ/, /ð/ and /ɹ/, while /z/, /ʃ/, /s/, /ʧ/ and /ʤ/ were often produced incorrectly as well. For the most part, these findings are consistent with the classification of late-8 sounds (Shriberg, 1993). One difference was with the classification of /ʒ/. This consonant was classed as "marginal" for all children participating in this study, as there was only one opportunity for children to produce /ʒ/ on the DEAP (*television*). The lack of other sampling of this sound makes it difficult to determine where it would fit in the classification system. The consistency of these findings is note-worthy, given that Shriberg (1993) based identification of sound acquisition on a clinical, rather than a population, sample of children.

The phonological processes most frequently produced by children in this study were fricative simplification, liquid deletion (in word-final position), cluster simplification and gliding, although other phonological patterns (such as later stopping, cluster reduction, voicing, final consonant deletion, and syllable structure deletions) were present less frequently (i.e., less than 40% of the available exemplars per child). Hodson and Paden (1981) reported the most common phonological processes among a group of unintelligible children and another group of intelligible children aged 3-8 years. Interestingly, the most common phonological processes in the present study were consistent with the processes demonstrated by children with intelligible speech in the study by Hodson and Paden (1981). This suggests there may be a difference in the type of speech disorders present in a sample recruited from the community (as in the current study), and those who typically present at clinic.

Differentiating Between Children with SSD who have and have not had Contact with an SLP

The current study enabled unique insights into the characteristics, nature, and severity of SSD in young children who had and had not had contact with an SLP. There were 56 children identified with SSD who had not had contact with an SLP (+SSD-SLP) and 35 children identified with SSD who had contact (+SSD+SLP). Compared with children in the +SSD-SLP group, children who had contact with an SLP (+SSD+SLP) were more likely to be unintelligible to strangers and acquaintances (but not family members, teachers and friends), have a lower PCC and PPC, have a lower pMLU, have a smaller consonant inventory, have more difficulties with liquids, use gliding and word-final liquid deletion, and be identified as being distressed about their speech. That is, the children with SSD whose parents had made contact with an SLP typically had a more a severe SSD at the impairment level and greater concerns about the impact of their speech skills on their children’s socialization and participation (McLeod & McCormack, 2007). Of the 35 children who had contact with an SLP, 34 had received an assessment and 29 had received intervention; however, the nature of intervention and the number of sessions is unknown. It is likely that the children who had received an SLP assessment were awaiting intervention, and those who had begun intervention had not had sufficient time to resolve their difficulties (cf. Glogowska, Roulstone, Enderby & Peters, 2000). McAllister et al. (2011) provide additional information about Sound Effects Study’s parents’ expectations and access to services, including results from interviews with parents whose children who had not had contact with an SLP. They indicated that there was a significant relationship between parental level of concern and seeking speech-language pathology services for children. It is important to note that there were 6 children in the -SSD+SLP group who had contact with an SLP but did not have SSD. It may be that their SSD had resolved, but parents had other concerns about their talking.

As mentioned previously, children in the +SSD-SLP group have rarely been studied within speech-language pathology literature. Overall, these children had less severe SSD that had less impact on their participation; however, they were still diagnosed with an SSD on the DEAP and would benefit from intervention. An examination of severity index scores revealed although they were more likely to receive ratings of mild-moderate, there were still children in the severe range. In comparison, the children in the +SSD+SLP group were more likely to receive a severity rating of moderate-severe. These findings are consistent with Broomfield and Dodd (2004b), who reported that the majority of children with SSD attending clinics in the UK presented with a moderate disorder. The severity ratings in the current study were based on the children's PCC scores, and given the difference in PCC between the +SSD-SLP and +SSD+SLP groups, a corresponding difference in severity ratings would be expected. In future research it would be interesting to investigate whether parents' perceptions of severity corresponded to clinical assessment of severity, and whether parent perceptions led to the involvement of SLPs.

In the current study, parents of children in the +SSD+SLP group were more likely to report their child's speech as being difficult for strangers to understand than the children in the +SSD-SLP group. It may be that perceptions of intelligibility are linked to severity of SSD. That is, children with a lower PCC may also be those that parents identified as having speech that was difficult for strangers to understand, and the combination of both resulted in their referral to SLPs. However, it is also possible that children whose speech was considered difficult for strangers to understand were referred by parents due to concerns about how the children would progress at school the following year, when many of the adults and peers would be unfamiliar listeners.

Another difference between the +SSD+SLP and the +SSD-SLP groups related to the occurrence of different phonological processes. It may be that parents and teachers are more likely to refer children to clinic when they have difficulty producing specific sounds, such as liquids, or when they present with particular processes, such as gliding. The process of gliding is typically eliminated by 4 to 5 years (Grunwell, 1997), and it is possible that parents who referred their children to clinic were concerned that the process was still evident in their child's speech. Previous research has indicated that individuals who misarticulate /ɹ/ are more likely to be judged negatively by peers (Silverman & Paulus, 1989), and it's possible that concern for their child's future social interactions may have influenced the parents in the current study.

A final and important area of difference between the +SSD-SLP and +SSD+SLP groups related to scores on the AusTOMs (Perry & Skeat, 2004). Both groups differed from those in the -SSD±SLP group on all subscales; however, the +SSD-SLP and +SSD+SLP groups differed from one another on the Wellbeing/Distress subscale. The Wellbeing/Distress subscale takes into consideration the "level of concern experienced by the individual… evidenced by anger, frustration, apathy, depression" (Perry & Skeat, 2004). Thus, it is possible that one of the factors that contributed to parents' decision to refer children to professionals for management of SSD relates to their concern for the way in which the SSD was affecting the child's social and emotional health and wellbeing. The association between SSD and children's participation in life activities has been established in multiple research studies (see for example, McCormack, Harrison, McLeod & McAllister, 2011; Teverovsky, Bickel & Feldman, 2007). It would be useful for further research to investigate the links between activity limitations associated with SSD, and parents' decision to seek services to assist their child's speech development.

Limitations

This study presents a comprehensive description of the speech of a sample of 143 preschool children who had been identified by their parents and/or teachers with concerns about their speech. The recruitment stage sought to screen over 1,000 4- to 5-year-old children attending early childhood settings. Although every effort was made to collect screening questionnaires on all 4- to 5-year-olds in the 33 early childhood recruitment sites, a disproportionate number of questionnaires were returned for boys versus girls (1.31:1). This ratio is considerably higher than the Australian population of boys to girls attending early childhood settings (1.05:1) (Harrison et al., 2009). Nevertheless, the sample who were assessed (n=143) were comparable to the nationally representative LSAC sample (n=999) on five socio-demographic characteristics including sex of child (see Table 1). A further limitation of this study is that a comparative sample of children who were *not* identified by parents and/or teachers was not studied in a similar way to determine if indeed there were more children who may benefit from speech-language pathology services.

Another limitation is that longitudinal follow-up of these children was not possible in order to document the natural history of the children who had not sought speech-language pathology services, and to determine the educational and social outcomes for these children. However, this study used the same inclusion criteria as the McLeod and Harrison (2009) analysis of children with speech and language concern from LSAC (n = 4,983), and so further analysis of the LSAC data that has been undertaken by the authors may provide some insights. Analyses of population samples have shown that children identified at 4 to 5 years with parent and/or teacher concern have significantly poorer educational and social outcomes than their non-identified peers (Harrison, McLeod, Berthesen, & Walker, 2009; McCormack et al., 2011; Roulstone, Miller, Wren, & Peters, 2009).

Clinical Implications and Future Research

Investigating SSD in the community enables a more complete understanding of the characteristics of SSD in children, specifically those who have not “been clinically identified and served” (Tomblin, 2010, p. 108). In contrast, basing our understanding of the nature of SSD on children *who present in clinics* for assessment and intervention restricts our knowledge of the nature of the disorder. The present study included children in the community with difficulty "talking and making speech sounds" who met clinical diagnostic criteria for SSD, but who had not been assessed or received intervention previously. It would be expected that severity of SSD would be a factor influencing attendance at speech-language pathology clinics. However, children in the present study who were not currently on clinical caseloads ranged from having mild to severe SSD. Thus, severity of disorder was not the only factor that influenced whether children attended speech-language pathology clinics. Factors such as intelligibility with strangers and reported distress also appeared to influence parents' and teachers' decisions to refer children for intervention.

It is concerning that some children in the general community who were identified by parents and/or teachers with concerns about their talking presented with moderate and severe disorder, and yet were not receiving speech-language pathology services to assist their speech development. Children who do not receive SLP intervention may experience difficulties at school with academic and social development (Law et al., 1998; McCormack et al., 2011). Further research with parents might provide additional insights into reasoning behind decisions to access speech-language pathology services, and enable the identification of barriers and facilitators along the clinical continuum (McAllister et al., 2011). It may be that SLPs need to develop their role in health promotion to raise awareness about identification of SSD in childhood, as well as the potential impact of childhood SSD on long-term outcomes. Integrated services within early childhood centers also may increase access to SLPs and facilitate receipt of earlier and appropriate intervention.

Conclusion

The impact of childhood SSD is both immediate and long lasting, extending into future educational, occupational and social outcomes (see McCormack et al., 2009 for a review). The ability to produce intelligible speech is essential for functioning in society (Hodson, 1994; Ruben, 2000), and so intelligible speech is an ultimate goal for intervention for children with impaired speech production

(Dodd & Bradford, 2000). Numerous interventions targeting childhood SSD have been shown to be effective in changing intelligibility, speech sound accuracy, and literacy skills (Baker & McLeod, 2011). Thus, there is a need for better identification of children with SSD so they may benefit from intervention, and reduce the likelihood of ongoing difficulties. The majority of research within the speech-language pathology profession has been undertaken with clinical samples. However, such research excludes individuals who are not currently part of a clinical caseload and may never have received an assessment or intervention. Failure to consider this population has implications for SLPs' service planning, knowledge of the characteristics of different disorders, and awareness of factors that result in individuals seeking and/or receiving services. Investigating SSD in a community (non-clinical) study provides valuable information that complements research within speech-language pathology clinics.

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Appendix. Communication characteristics of the children identified by teachers and/or parents as having difficulty "talking and making speech sounds" (n = 143)

Aspect of communication	**Assessment tool**	**Subscale**	**Mean (SD)**	**Range**	**n (%) children WNL**	**n (%) children NOT WNL**	**Valid data**
Receptive Language / Cognition	Peabody Picture Vocabulary Test (short form) (PPVT, Dunn & Dunn, 1997)	Short form scaled score (Rothman, 2003)	61.9 (6.8)	35.9-76.4	109 (80.1%)	27 (19.9%)	136
Expressive Language	Action Picture Test (Renfrew, 1997a)	Grammar	17.3 (5.4)	2-29	85 (61.2%)	54 (38.8%)	139
		Information	27.8 (5.3)	7-38.5	116 (83.5%)	23 (16.5%)	139
	The Bus Story (Renfrew, 1997b)	Information	20.4 (9.9)	3-44	104 (75.4%)	34 (24.6%)	138
		Subordinate clauses	0.8 (1.0)	0-5	-	-	138
		5 longest sentences	7.9 (2.5)	1-14.6	-	-	138
Hearing	Pure-tone audiometry (1000, 2000, 4000Hz) (ASHA, 1985)		-	-	69 (57.0%)	52 (43.0%)	121
Oromotor skills	Diagnostic Evaluation of Articulation and Phonology (DEAP) – Oromotor subtest (Dodd et al., 2002)	Isolated movements (out of a total possible of 12)	10.6 (1.6)	5-12	126 (90.0%)	14 (10.0%)	140
		Sequenced movements (out of a total possible of 18)	16.4 (1.8)	11-18	139 (99.3%)	1 (0.7%)	140
		DDK (out of a total possible of 9)	6.9 (1.9)	0-9	132 (95.0%)	7 (5.0%)	139
Voice	Australian Therapy Outcome Measures (AusTOMs, Skeat & Perry, 2004)	Voice – Impairment (5 = no impairment)	4.9 (0.3)	3-5	128 (90.1%)	14 (9.9%)	142
Fluency	AusTOMs (Skeat & Perry, 2004)	Fluency – Impairment (5 = no impairment)	4.8 (0.4)	3-5	115 (81.6%)	26 (18.4%)	141
Pre-literacy and pre-numeracy skills	Who am I? (De Lemos & Doig, 1999)	Overall scaled score	60.0 (7.0)	45.0-77.8	97 (69.8%)	42 (30.2%)	139
Phonological awareness	Pre-reading Inventory of Phonological Awareness (PIPA,	Syllable Segmentation (possible total of 12)	5.3 (2.7)	0-12	58 (74.3%)	20 (25.6%)	78

Dodd, Crosbie, McIntosh, Teitzel, & Ozanne, 2000)	Rhyme Awareness (possible total of 12)	3.8 (2.4)	0-11	37 (45.1%)	45 (54.9%)	82
	Alliteration Awareness (possible total of 12)	3.0 (1.6)	0-12	70 (82.3%)	15 (17.6%)	85
	Phoneme Isolation (possible total of 12)	1.0 (2.7)	0-11	30 (56.6%)	23 (43.4%)	53
	Letter Knowledge (possible total of 32)	2.0 (3.9)	0-21	-	-	88

WNL = Within normal limits

Table 1

Characteristics of the Sound Effects Study sample (n = 143) and the nationally representative sample (n = 999) of 4- to 5-year-old children identified by their parents/teachers with concerns about how they talked and made speech sounds

	Sound Effects Study sample of children with parent/teacher concerns (n = 143)		Nationally representative sample of children with parent concerns (n = 999)	
	n	%	n	%
Boys: girls	96 : 47	67.1% : 32.9%	644 : 355	64.5% : 35.5%
Indigenous status[a]	4	3.7%	37	3.7%
Child has older sibling(s) at home [a]	71	65.1%	616	61.6%
Child has younger sibling(s) at home [a]	54	49.5%	463	46.3%
Language other than English spoken at home [a]	10	9.3%	150	15.0%
Mother completed secondary school (Year 12) [a]	75	68.8%	436	43.6%
Father completed secondary school (Year 12) [a]	62	58.5%	385	38.5%
	Mean	SD	Mean	SD
Child age (months)	55.7	5.0	56.7	2.6
Family income (level per week) [b]	11.1	3.2	10.2	2.8
Index of Relative Socio-Economic Disadvantage [a c]	1014.5	43.3	1000.2	73.3

[a] valid data were available for 109 children whose parents returned the study questionnaire
[b] valid data were available for 98 children. Income level 10 = $800 - $999; income level 11 = $1000 - $1499 per week
[c] Index of Relative Socioeconomic Advantage and Disadvantage (Australian Bureau of Statistics, 2008)

Table 2

Relationship between diagnostic identification and contact with speech-language pathology services for the Sound Effects Study sample of 4- to 5-year-old children (n = 109) based on the four diagnostic quadrants described by Bishop and McDonald (2009, p. 602)

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">Child identified with speech sound disorder on the DEAP</td></tr>
<tr><td>NO</td><td>YES</td></tr>
<tr><td rowspan="2">Parent/teacher concern resulted in contact with speech-language pathology service</td><td>NO</td><td>Quadrant A (-SSD-SLP):
Truly unaffected
(n = 12)
PCC: M = 84.83 SD = 5.95</td><td>Quadrant B (+SSD-SLP):
False positive OR true cases unidentified by services
(n = 56)
PCC[a]: M = 68.84 SD = 11.34</td></tr>
<tr><td>YES</td><td>Quadrant C (-SSD+SLP):
Overconcern, OR resolved problem, OR missed by diagnostic method
(n = 6)
PCC: M = 88.88 SD = 4.63</td><td>Quadrant D (+SSD+SLP):
Truly affected
(n = 35)
PCC[a]: M = 63.17 SD = 13.75</td></tr>
</table>

Note. Diagnostic quadrants A-D were described by Bishop and McDonald (2009, p. 602). DEAP = Diagnostic Evaluation of Articulation and Phonology (Dodd et al., 2002), -SSD = was not identified with speech sound disorder on the DEAP, +SSD = was identified with speech sound disorder on the DEAP, -SLP = no contact with speech-language pathology services, + SLP = contact with speech-language pathology services, PCC = percentage of consonants correct, *M* = Mean, *SD* = Standard deviation.

[a]Differences between PCC mean scores for quadrants B and D were confirmed by ANOVA, $F = 4.10$, $p \leq .05$, and by the non-overlap of their respective 95% confidence intervals ('a-a' superscript pairs).

Table 3

Independent phonetic inventories for the Sound Effects Study sample of children: Relationship between diagnostic identification and contact with speech-language pathology services

	TOTAL SAMPLE n=143		QUADRANTS A and C (-SSD±SLP) n= 18		QUADRANT B (+SSD-SLP) n = 56		QUADRANT D (+SSD+SLP) n = 35		ANOVA 3 group comparison A+C vs. B vs. D	ANOVA 2 group comparison B vs. D
	M (SD)	Range	*M*(SD)	Range	*M*(SD)	Range	*M*(SD)	Range	F-ratio	F-ratio
Consonant inventory	19.10 (1.86)	10-23	20.56 (1.46)	17-22	19.36 (1.72)	15-23	18.60 (1.44)	16-22	8.98**	4.71*
Consonant cluster inventory	19.81 (5.56)	1-27	23.33 (1.50)	20-26	20.50 (5.38)	3-26	18.77 (6.31)	5-27	4.41*	1.94
Vowel inventory	19.62 (0.70)	16-21	19.67 (0.69)	18-21	19.61 (0.65)	18-21	19.77 (0.60)	19-21	0.71	1.46
Total inventory	38.91 (6.74)	11-49	43.89 (2.08)	40-47	39.84 (6.30)	18-49	37.37 (7.03)	23-49	6.83**	3.03†

* $p < .05$; ** $p < .01$; † $p < .10$

Table 4

Identification of speech sound disorder using the Diagnostic Evaluation of Articulation and Phonology: Phonology subtest (DEAP, Dodd et al., 2002) (n = 143)

	Mean (SD)	Range	% children WNL	% children with SSD		
				% children 0 - 1 SD below mean	% children 1 - 2 SD below mean	% children >2 SD below mean
PPC Total	78.0 (10.5)	38.0 – 97.7	16 (11.2%)	12 (8.4%)	26 (18.2%)	89 (62.2%)
PVC Total	95.5 (5.2)	62.8 – 100	55 (38.5%)	9 (6.3%)	25 (17.5%)	54 (37.8%)
PCC Total	68.1 (14.3)	17.9 – 96.4	19 (13.3%)	12 (8.4%)	19 (13.3%)	93 (65.0%)

Note. PPC = percentage of phonemes correct; PVC = percentage of vowels correct; PCC = percentage of consonants correct; WNL = Within normal limits (Standard score = 7-13); SSD = Speech sound disorder identified (Standard score = 3-6)

Table 5

Relational analysis of speech skills for the Sound Effects Study sample of children: Relationship between diagnostic identification and contact with speech-language pathology services

	TOTAL SAMPLE n=143		QUADRANTS A and C (-SSD±SLP) n= 18		QUADRANT B (+SSD-SLP) n = 56		QUADRANT D (+SSD+SLP) n = 35		ANOVA 3 group comparison A+C vs. B vs. D	ANOVA 2 group comparison B vs. D
	M (SD)	Range	*M* (SD)	Range	*M* (SD)	Range	*M* (SD)	Range	F-ratio	F-ratio
PCC	68.1 (14.3)	38.0 – 97.7	86.2 (5.75)	78.4– 96.4	68.8 (11.34)	40.3– 90.6	63.2 (13.74)	32.6– 88.5	24.19**	4.57*
PVC	95.5 (5.2)	62.8 – 100	98.6 (1.74)	94.9– 100.0	95.7 (4.56)	80.8– 100.0	94.9 (4.84)	79.5– 100.0	4.60*	0.56
PPC	78.0 (10.5)	17.9 – 96.4	90.7 (3.81)	85.3– 97.7	78.5 /(8.29)	55.8– 93.1	74.6 (9.98)	52.3– 92.2	22.40**	4.10*
PCC Stops	89.88 (15.07)	15.9 – 100.0	95.8 (8.59)	63.6– 100.0	90.8 (12.77)	25.0– 100.0	88.6 (14.53)	38.6– 100.0	1.90	0.58
PCC Nasals	96.39 (7.89)	47.1 – 100.0	98.5 (4.19)	83.3– 100.0	96.6 (7.77)	61.1– 100.0	95.9 (6.66)	77.8– 100.0	0.83	0.23
PCC Fricatives	58.54 (17.40)	6.7 – 91.1	77.1 (10.87)	46.7– 91.1	58.8 (14.45)	13.3– 86.7	52.8 (18.56)	13.0– 84.4	15.04**	2.95†
PCC Affricates	58.34 (36.69)	0.0 – 100.0	90.5 (12.98)	57.1– 100.0	54.8 (36.21),	0–100.0	46.9 (36.26)	0–100.0	10.54**	1.03
PCC Glides	80.94 (21.29)	0.0 – 100.0	86.9 (17.72)	50.0– 100.0	84.8 (19.91)	50.0– 100.0	76.6 (23.89)	0–100.0	1.54	1.30
PCC Liquids	58.19 (28.76)	0.0 – 100.0	88.9 (15.74)	50.0– 100.0	62.0 (24.13)	6.7– 100.0	44.8 (26.54)	0–92.9	20.44**	10.15**
PCC Clusters	39.97 (22.50)	0.0 – 93.8	72.7 (15.05)	51.6– 93.8	39.8 (18.91)	3.2– 87.1	33.7 (19.21)	0–81.3	28.59**	2.20
PCC Cluster elements	58.58 (17.73)	15.2 – 97.1	83.0 (9.85)	69.1– 97.1	59.4 (14.45)	27.3– 93.9	53.0 (16.31)	21.2– 88.2	26.50**	3.82*
PCC (Early 8)	87.42 (9.05)	43.1– 100.0	94.7 (3.25)	88.5– 100	88.2 (6.63)	63.3– 98.4	84.94 (9.04)	48.4– 96.6	11.18**	3.94*
PCC	78.17	6.9–	90.45	54.3–	79.45	26.4–	75.25	27.8–	4.76**	1.18

(Middle 8)	(19.40)	100.0	(11.27)	100	(16.53)	100	(20.07)	100		
PCC (Late 8)	44.30 (21.29)	7.2–94.1	75.5 (12.70)	54.4–94.1	44.36 (17.23)	9.0–83.8	35.22 (17.64)	10–82.4	35.48**	5.96*
ACI	36.63 (10.39)	10.2–96.0	48.73 (2.08)	40–96	36.66 (7.28)	20.3–58.7	33.71 (7.89)	18.3–51.8	14.84**	3.32†
Substitutions	77.5 (14.2)	24.6–100.0	87.63 (8.31)	73.7–100	76.30 (15.65)	24.6–100	77.07 (13.03)	53.5–100	4.78**	0.06
Omissions: single sound	5.1 (5.4)	0.0–30.3	3.36 (3.90)	0–13.6	5.65 (5.88)	0–29.9	4.70 (4.11)	0–17.7	1.46	0.70
Omissions: whole cluster	0.1 (0.4)	0.0–3.3	0	–	0.11 (0.43)	0–2.6	0.07 (0.27)	0–1.3	0.68	0.26
Omission: part cluster	11.2 (8.7)	0.0–47.1	7.17 (6.48)	0–21.1	10.34 (8.52)	0–33.3	11.47 (8.94)	0–30.1	1.59	0.36
Distortions	3.2 (9.6)	0.0–62.8	0.20 (0.85)	0–3.6	4.01 (12.16)	0–62.8	3.59 (8.72)	0–39.5	1.01	0.03
Additions	3.0 (3.3)	0.0–17.0	1.64 (3.03)	0–11.1	3.70 (3.67)	0–17.0	3.12 (3.39)	0–14.3	2.37†	0.57
pMLU	5.54 (0.49)	3.47–6.35	6.09 (0.16)	5.84–6.35	5.57 (0.41)	4.22–6.13	5.40 (0.48)	4.31–6.13	17.16**	2.95†
Maximum pMLU	6.46 (0.51)	6.25–6.68	6.46 (0.05)	6.32–6.55	6.45 (0.47)	6.28–6.57	6.46 (0.45)	6.32–6.54	0.26	0.31
Word shape match	92.9 (8.4)	51.3–100.0	97.80 (1.75)	93.8–100	93.02 (7.35)	60–100	91.99 (8.11)	63.8–100	4.29*	0.39
Word stress match	97.2 (2.7)	87.2–100.0	98.62 (1.54)	96.1–100	97.03 (2.73)	87.5–100	97.16 (2.34)	91.3–100	3.01*	0.06
Multisyllabic word match	93.7 (6.7)	63.0–100.0	97.52 (2.87)	92.3–100	93.34 (6.14)	81.5–100	93.64 (5.95)	81.5–100	3.88*	0.05
Intelligibility Index	95.5 (5.6)	65–100	97.99 (2.53)	92.5–100	95.91 (5.09)	68.4–100	94.7 (6.69)	65.0–100	2.03	0.92

Note. DEAP = Diagnostic Evaluation of Articulation and Phonology (Dodd et al., 2002), M = Mean, *SD* = Standard deviation, PCC = percentage of consonants correct, PVC = percentage of vowels correct, PPC = percentage of phonemes correct, ACI = Articulation Competence Index, pMLU = phonological mean length of utterance
* $p < .05$; ** $p < .01$; † $p < .10$

Table 6

Accuracy of singleton consonant production on the Diagnostic Evaluation of Articulation and Phonology Articulation and Phonology Subtests (DEAP, Dodd et al., 2002) (n = 143)

Consonant	Early/ Middle/ Late 8[#]	% Correct Mean (SD)	Always Incorrect n	(%)	Marginal* n	(%)	Always Correct n	(%)
/w/	early	97.0% (14.2)	2	(1.4%)	6	(4.2%)	135	(94.4%)
/m/	early	97.7% (7.3)	0	(0%)	16	(11.2%)	127	(88.8%)
/n/	early	97.0% (8.7)	0	(0%)	21	(14.7%)	122	(85.3%)
/b/	early	96.9% (10.3)	0	(0%)	21	(14.7%)	122	(85.3%)
/h/	early	95.3% (14.6)	1	(0.7%)	15	(10.5%)	127	(88.8%)
/d/	early	94.8% (13.2)	1	(0.7%)	26	(18.2%)	116	(81.1%)
/ŋ/	middle	93.5% (20.5)	4	(2.8%)	12	(8.4%)	127	(88.8%)
/p/	early	93.0% (18.4)	2	(1.4%)	22	(15.4%)	119	(83.2%)
/g/	middle	88.7% (24.6)	6	(4.2%)	35	(24.5%)	102	(71.3%)
/t/	middle	87.6% (19.5)	2	(1.4%)	78	(54.5%)	63	(44.1%)
/f/	middle	86.8% (27.9)	6	(4.2%)	33	(23.1%)	104	(72.7%)
/k/	middle	85.3% (27.0)	8	(5.6%)	45	(31.5%)	90	(62.9%)
/l/	late	77.4% (32.5)	7	(4.9%)	64	(44.8%)	72	(50.3%)
/v/	middle	67.0% (32.8)	13	(9.1%)	78	(54.5%)	52	(36.4%)
/j/	early	65.0% (38.6)	19	(13.3%)	51	(35.7%)	73	(51.0%)
/ʧ/	middle	59.1% (40.6)	31	(21.7%)	55	(38.5%)	57	(39.9%)
/s/	late	57.5% (39.2)	33	(23.1%)	73	(51.0%)	37	(25.9%)
/ʃ/	late	58.7% (42.0)	36	(25.2%)	49	(34.3%)	58	(40.6%)
/ʤ/	middle	58.4% (37.1)	27	(18.9%)	68	(47.6%)	48	(33.6%)
/z/	late	45.5% (38.0)	44	(30.8%)	69	(48.3%)	30	(21.0%)
/ʒ/	late	44.8% (49.9)	0	(0%)	143	(100.0%)	0	(0%)
/ɹ/	late	29.4% (39.5)	78	(54.5%)	43	(30.1%)	22	(15.4%)
/ð/	late	23.8% (30.9)	80	(55.9%)	57	(39.9%)	6	(4.2%)
/θ/	late	7.8% (17.0)	109	(76.2%)	33	(23.1%)	1	(0.7%)

Note. # = Shriberg (1993) *Marginal = either correct on some but not all occasions, or an insufficient sample was obtained to determine consistency (typically only one example was obtained).

Table 7

Accuracy of vowel and diphthong production on the Diagnostic Evaluation of Articulation and Phonology Articulation and Phonology Subtests (DEAP, Dodd et al., 2002) (n = 143)

Vowel/ diphthong (MD)	Vowel/ diphthong (HCE)	Example	Mean (SD) % correct	Always Incorrect n (%)	Marginal* n (%)	Always Correct n (%)
/ɛə/	/eː/	*hair*	100.0% (0)	1 (0.7%)	0 (0%)	142 (99.3%)
/ɪ/	/ɪ/	*hit*	99.0% (2.9)	0 (0%)	18 (12.6%)	125 (87.4%)
/a/	/ɐː/	*heart*	98.8% (6.1)	0 (0%)	5 (3.5%)	138 (96.5%)
/i/	/iː/	*heat*	98.7% (5.0)	0 (0%)	12 (8.4%)	131 (91.6%)
/ʌ/	/ɐ/	*hut*	98.5% (4.0)	0 (0%)	18 (12.6%)	125 (87.4%)
/oʊ/	/əʉ/	*hoe*	98.4% (10.0)	0 (0%)	4 (2.8%)	139 (97.2%)
/ɔ/	/oː/	*port*	98.3% (9.2)	0 (0%)	5 (3.5%)	138 (96.5%)
/ʊ/	/ʊ/	*put*	98.3% (7.2)	0 (0%)	8 (5.6%)	135 (94.4%)
/ɒ/	/ɔ/	*hot*	97.8% (7.5)	0 (0%)	14 (9.8%)	129 (90.2%)
/eɪ/	/æɪ/	*hay*	97.4% (13.2)	2 (1.4%)	5 (3.5%)	136 (95.1%)
/ɔɪ/	/ɔɪ/	*boy*	96.2% (18.8)	5 (3.5%)	1 (0.7%)	137 (95.8%)
/æ/	/æ/	*hat*	95.5% (9.8)	0 (0%)	40 (28.0%)	103 (72.0%)
/aɪ/	/ɑe/	*high*	95.6% (13.1)	0 (0%)	21 (14.7%)	122 (85.3%)
/aʊ/	/æɔ/	*how*	95.1% (19.1)	4 (2.8%)	6 (4.2%)	133 (93.0%)
/ɪə/	/ɪə/	*hear*	94.1% (20.1)	4 (2.8%)	9 (6.3%)	130 (90.9%)
/u/	/ʉː/	*who*	93.8% (14.0)	0 (0%)	24 (16.8%)	119 (83.2%)
/ɜ/	/ɜː/	*her*	92.7% (24.4)	1 (0.7%)	108 (75.5%)	34 (23.8%)
/ɛ/	/e/	*pet*	91.0% (13.1)	0 (0%)	64 (44.8%)	79 (55.3%)
/ə/	/ə/	*schwa*	90.6% (12.6)	0 (0%)	80 (55.9%)	63 (44.1%)

Note. MD = Mitchell and Dellbridge (1965) symbols; HCE = (Harrington, Cox & Evans, 1997). The DEAP uses the MD symbols; however, recent acoustic analysis suggests that the HCE symbols are a more accurate representation of Australian English (see Cox, 2008).

*Marginal = either correct on some but not all occasions, or an insufficient sample was obtained to determine consistency (typically only one example was obtained).

Table 8

Presence of phonological processes on the Diagnostic Evaluation of Articulation and Phonology Articulation and Phonology Subtests (DEAP, Dodd et al., 2002) analysed using PROPH+ (n = 143)

Phonological process	Example	TOTAL SAMPLE n=143		QUADRANTS A and C (–SSD±SLP) n= 18		QUADRANT B (+SSD–SLP) n = 56		QUADRANT D (+SSD+SLP) n = 35		ANOVA 3 group comparison A+C vs. B vs. D	ANOVA 2 group comparison B vs. D
		M (SD)	Range	*M* (SD)	Range	*M* (SD)	Range	*M* (SD)	Range	F-ratio	F-ratio
1. Fricative simplification	*thumb* /θʌm/ → [fʌm]	54.1 (20.19)	0–89.0	57.1 (13.59)	11.0–83.0	55.2 (19.26)	0–78.0	53.0 (21.85)	0–89.0	0.27	0.27
2. Liquid deletion	*apple* /æpəl/ → [æpʊ]	3.8 (7.30)	0–38.0	1.8 (3.05)	0–7.0	2.5 (5.57)	0–29.0	5.69 (9.50)	0–38.0	2.93†	4.08*
3. Cluster simplification	*bread* /bɹɛd/ → [bwɛd]	36.5 (31.73)	0–100.0	10.4 (24.33)	0–86.0	38.8 (31.21)	0–100.0	46.5 (30.78)	0–93.0	8.88**	1.32
4. Gliding	*ring* /ɹɪŋ/ → [wɪŋ]	35.5 (27.10)	0–100.0	8.1 (13.70)	0–43.0	33.1 (24.00)	0–100.0	46.6 (24.03)	7–100.0	17.15**	6.83*
5. Cluster reduction	*bread* /brɛd/ → [bɛd]	23.0 (24.33)	0–90.0	5.8 (5.80)	0–16.0	20.2 (22.26)	0–90.0	28.7 (29.09)	0–87.0	5.81**	2.47
6. Palatal fronting	*sheep* /ʃip/ → [sip]	15.8 (24.50)	0–94.0	2.1 (6.04)	0–25.0	18.2 (25.34)	0–94.0	19.8 (26.81)	0–94.0	3.74*	0.08
7. Later stopping	*this* /ðɪs/ → [dɪs]	16.6 (11.67)	0–57.0	10.6 (6.97)	0–26.0	18.3 (10.81)	0–45.0	19.1 (14.52)	0–57.0	3.64*	0.11
8. Velar fronting	*car* /ka/ → [ta]	7.0 (15.42)	0–96.0	6.7 (15.96)	0–63.0	8.0 (17.64)	0–96.0	5.8 (12.25)	0–54.0	0.20	0.39

9. Deaffrication	*chair* /ʧɛə/ → [ʃɛə]	4.6 (10.86)	0–56.0	1.2 (3.56)	0–11.0	5.1 (12.55)	0–56.0	3.5 (7.90)	0–33.0	1.07	0.51
10. Early stopping	*foot* /fʊt/ → [pʊt]	3.2 (9.28)	0–55.0	0.5 (1.15)	0–3.0	2.6 (6.53)	0–42.0	5.6 (13.90)	0–55.0	2.08	1.93
11. Final consonant deletion	*bird* /bɜd/ → [bɜ]	4.6 (11.16)	0–93.0	0.8 (1.22)	0–4.0	5.1 (11.06)	0–62.0	3.8 (6.47)	0–33.0	1.70	0.44

Note. Both the Articulation and Phonology subtests were entered into the PROPH+ computer program in order to calculate presence of phonological processes.
* *p* < *.05;* ** *p* < *.01;* † *p* < *.10*

Table 9

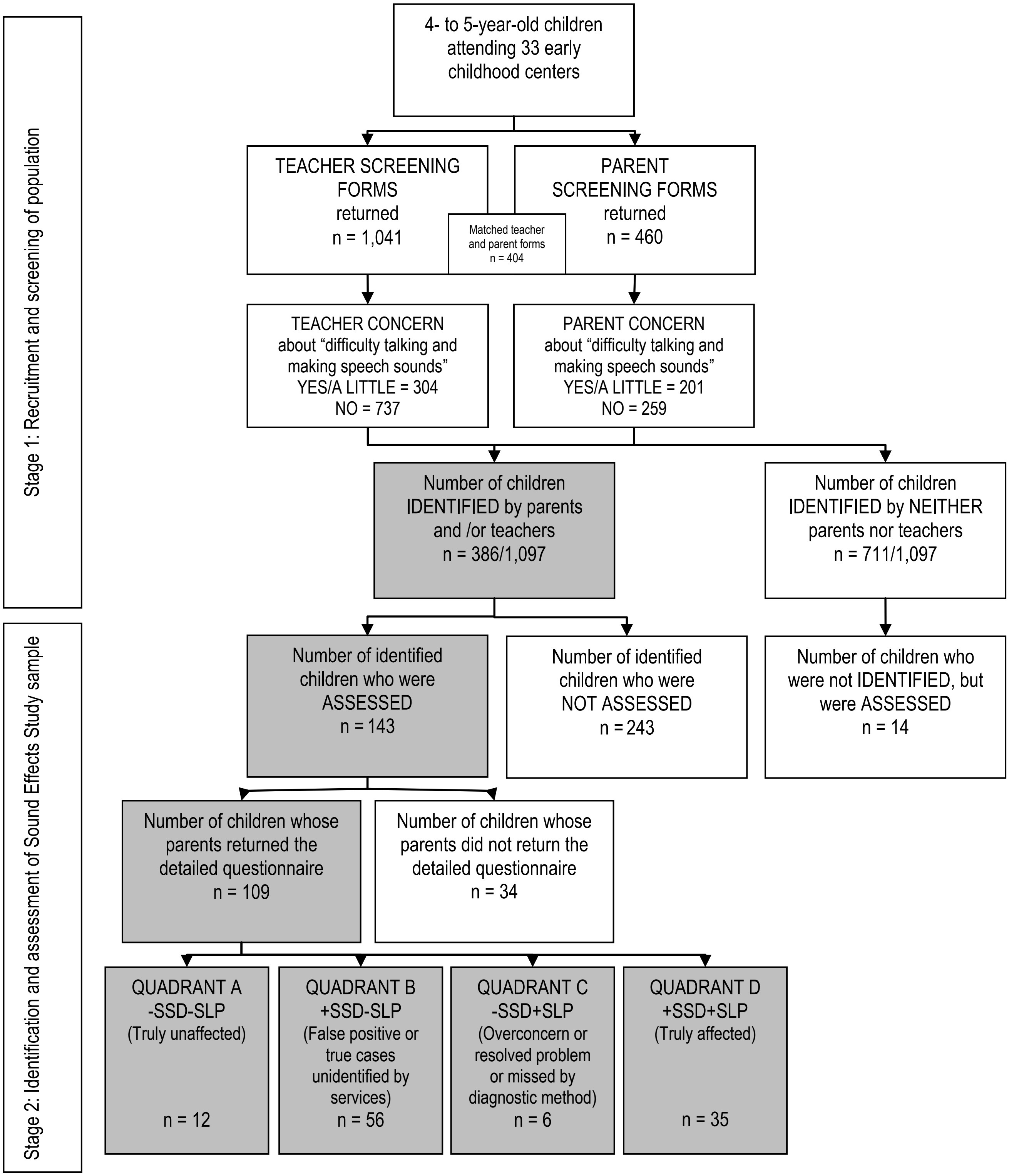
Intelligibility in Context Scale: Relationship between diagnostic identification and contact with speech-language pathology services

	TOTAL SAMPLE n=143		QUADRANTS A and C (–SSD±SLP) n= 18		QUADRANT B (+SSD–SLP) n = 56		QUADRANT D (+SSD+SLP) n = 35		ANOVA 3 group comparison A+C vs. B vs. D	ANOVA 2 group comparison B vs. D
	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range	F-ratio	F-ratio
1. Do you understand your child?	4.3 (0.6)	3–5	4.56 (0.51)	4–5	4.36 (0.52)	3–5	4.17 (0.53)	3–5	3.38*	2.72
2. Do immediate members of your family understand your child?	4.1 (0.6)	3–5	4.39 (0.50)	4–5	4.09 (0.56)	3–5	3.91 (0.55)	3–5	4.50**	2.19
3. Do extended members of your family understand your child?	3.8 (0.7)	2–5	4.11 (0.47)	3–5	3.79 (0.59)	3–5	3.62 (0.69)	2–5	3.91*	1.60
4. Do your child's friends understand your child?	3.8 (0.7)	2–5	3.89 (0.47)	3–5	3.82 (0.72)	2–5	3.68 (0.59)	3–5	0.81	0.99
5. Do other acquaintances understand your child?	3.6 (0.7)	2–5	3.78 (0.55)	3–5	3.65 (0.75)	2–5	3.39 (0.60)	2–4	2.56†	3.20†
6. Do your child's teachers understand your child?	4.0 (0.5)	3–5	4.06 (0.24)	4–5	3.98 (0.56)	3–5	3.91 (0.52)	3–5	0.51	0.38
7. Do strangers understand your child?	3.4 (0.7)	2–5	3.72 (0.57)	3–5	3.52 (0.74)	2–5	3.20 (0.63)	2–4	4.07*	4.44*

Note. Mean scores were generated from responses on a 5 point scale where 1 = *never*, 2 = *rarely*, 3 = *sometimes*, 4 = *usually*, 5 = *always* (McLeod et al., 2012)
* $p < .05$; ** $p < .01$; † $p < .10$

Figure legend

Figure 1. Derivation of participants for the stages of the Sound Effects Study. Shaded boxes indicate the groups in focus for the current paper.


Stage 1: Recruitment and screening of population
Stage 2: Identification and assessment of Sound Effects Study sample
4- to 5-year-old children attending 33 early childhood centers
TEACHER SCREENING FORMS returned n = 1,041
PARENT SCREENING FORMS returned n = 460
Matched teacher and parent forms n = 404
TEACHER CONCERN about "difficulty talking and making speech sounds" YES/A LITTLE = 304 NO = 737
PARENT CONCERN about "difficulty talking and making speech sounds" YES/A LITTLE = 201 NO = 259
Number of children IDENTIFIED by parents and /or teachers n = 386/1,097
Number of children IDENTIFIED by NEITHER parents nor teachers n = 711/1,097
Number of identified children who were ASSESSED n = 143
Number of identified children who were NOT ASSESSED n = 243
Number of children who were not IDENTIFIED, but were ASSESSED n = 14
Number of children whose parents returned the detailed questionnaire n = 109
Number of children whose parents did not return the detailed questionnaire n = 34
QUADRANT A -SSD-SLP (Truly unaffected) n = 12
QUADRANT B +SSD-SLP (False positive or true cases unidentified by services) n = 56
QUADRANT C -SSD+SLP (Overconcern or resolved problem or missed by diagnostic method) n = 6
QUADRANT D +SSD+SLP (Truly affected) n = 35