Author(s): McLeod, S.L.; Crowe, K.M.; Shahaeian, A.

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RUNNING HEAD: INTELLIGIBILITY IN CONTEXT SCALE

Intelligibility in Context Scale: Normative and validation data for English-speaking preschoolers

Sharynne McLeod

Kathryn Crowe

Ameneh Shahaeian

Charles Sturt University, Bathurst, Australia

Correspondence:

Sharynne McLeod

Charles Sturt University

Panorama Ave, Bathurst, NSW, 2795 Australia

Tel: +61-2-63384463

Email: smcleod@csu.edu.au

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Abstract

Purpose: To describe normative and validation data on the Intelligibility in Context Scale (ICS, McLeod, Harrison, & McCormack, 2012a) for English-speaking children.

Method: The ICS is a seven item parent report measure of children's speech intelligibility with a range of communicative partners. Data were collected from the parents of 803 Australian English-speaking children aged 4;0 to 5;5 (37.0% were multilingual).

Results: The mean ICS score was 4.4 (*SD* = 0.7) of a possible total score of 5. Children's speech was reported to be most intelligible to their parent, followed by their immediate family, friends, and teachers, and least intelligible to strangers. The ICS had high internal consistency (α = .94). Significant differences in scores were identified based on sex and age, but not socioeconomic status (SES) or the number of languages spoken. There were significant differences in scores between children whose parents had concerns about their child's speech (*M* = 3.9) and those who did not (*M* = 4.6). Sensitivity of .82 and specificity of .58 was established as the optimal cut-off. Test-retest reliability and criterion validity was established for 184 children with speech sound disorder. There was a significant low correlation between the ICS mean score and percentage of phonemes correct (PPC, *r* =.30), percentage of consonants correct (PCC, *r* =.24), and percentage of vowels correct (PVC, *r* =.30) on the Diagnostic Evaluation of Articulation and Phonology (Dodd et al., 2002). Thirty-one parents completed the ICS about English and another language spoken by their child with speech sound disorder. The significant correlations between the scores suggest that the ICS may be robust between languages.

Conclusion: This paper provides normative ICS data for English-speaking children and additional validation of the psychometric properties of the ICS. The robustness of the ICS was suggested since mean ICS scores were not affected by SES, number of languages spoken, or whether the ICS was completed about English or another language. The ICS is recommended as a screening measure of children's speech intelligibility.

Keywords: intelligibility, speech, speech sound disorders, children, ICF-CY

Intelligibility in Context Scale: Normative and validation data for English-speaking preschoolers

Speech intelligibility is defined by Weismer (2009) as “a relative measure of the degree to which a speaker’s speech signal is understood, the relativity depending at a minimum on the identities of the speaker and listener, what is spoken, and where it is spoken” (p. 569). Speech intelligibility is a complex concept that is influenced by not only the speech signal, but also by speaker and listener characteristics and familiarity, visual cues, shared knowledge and context, and the environment (Ertmer, 2010; Huttunen & Sorri, 2004; Weston & Shriberg, 1992). Reduced speech intelligibility can occur as the consequence of many communication impairments, including those with an aetiology that is linguistic (e.g., speech sound disorder), neuromotor (e.g., dysarthria), or sensory (e.g., hearing loss).

Poor speech intelligibility can lead to communication difficulties in a range of environments such as at home, school, and in everyday life (Ertmer, 2010, 2011) and with a range of communication partners (Coplan & Gleason, 1998; Flipsen, 1995; McLeod, Harrison, & McCormack, 2012b). Monsen (1981) stated that the real world meaning of poor speech intelligibility is that “listeners are confronted with overwhelming difficulty understanding what was said. Only occasional words will be picked out of the flow of speech” (p. 850). However, the consequences of reduced speech intelligibility reach far beyond a speaker’s immediate need to communicate a message. For example, Most (2007) described a significant correlation between speech intelligibility, loneliness, and sense of coherence for children with hearing loss in integrated education settings in Israel. For these children, intelligible speech was important for social competence and forming and maintaining social relationships with peers (Most, 2007; Most, Ingber, & Heled-Ariam, 2012).

Describing speech intelligibility is an important aspect of clinical speech evaluation. Traditional single word-based assessment of speech production provides some insight into how well an individual's connected speech can be understood; however, additional measures of speech intelligibility are needed to describe functional speech skills (Ertmer, 2010; Lousada, Jesus, Hall, & Joffe, 2014; Miller, 2013). While the relationship between articulation and intelligibility has long been scrutinized (Hudgins & Numbers, 1942) this relationship is still poorly understood.

Methods for assessing speech intelligibility vary along a number of dimensions including the assessment method, the length of utterance evaluated, the role and number of listeners/evaluators (Crowe & McLeod, 2014). Kent, Miolo, and Bloedel (1994) describe three main assessment methods for children: rating scales (e.g., Speech Intelligibility Rating scale, Allen, Nikolopoulos, Dyar, & O'Donoghue, 2001), single word measures (e.g., Children's Speech Intelligibility Measure, Wilcox & Morris, 1999; Swedish Test of Intelligibility for Children, Lagerberg, Hartelius, Johnels, Ahlman, Börjesson, & Persson, 2015), and connected speech measures (Beginners' Intelligibility Test, Osberger, McConkey Robbins, Todd, & Riley, 1994; Intelligibility Index, Flipsen, 2006).

In a busy clinical setting, speech intelligibility measures that utilize a numeric scale are undoubtedly the most practical as they are quick and easy to complete. Speech intelligibility measures of this type ask the reporter (e.g., a clinician or a communication partner) to rate on a numeric scale how well a person's speech can be understood (Ertmer, 2010). While such scales are available, there is a need for measures of speech intelligibility that are valid and reliable, as well as being quick and easy for clinicians to administer (Huttunen & Sorri, 2004).

The Intelligibility in Context Scale (ICS, McLeod, Harrison & McCormack, 2012a; http://www.csu.edu.au/research/multilingual-speech/ics) is a parent report measure that considers children's intelligibility with different communicative partners. The seven items were informed by consideration of Environmental factors listed in the International Classification of Functioning, Disability, and Health: Children and Youth (ICF-CY, World Health Organization, 2007). Miller (2013) indicated that the ICS offered a measure for considering functional success and stated "making such combined judgement has the advantage that it permits one to gain inroads into what counts as a clinically, communicatively, as opposed to merely statistically significant change in intelligibility, either generally, or, more realistically, in relation to given listeners, in given situations" (p. 608). The ICS was originally validated on 120 Australian English-speaking preschool-aged children (McLeod et al., 2012b). In this validation study, the ICS was found to have high internal consistency (α= .93), sensitivity, and construct validity. Criterion validity was established through significant correlations between the ICS and percentage of phonemes correct (PPC, r =.54), percentage of consonants correct (PCC, r =.54), and percentage of vowels correct (PVC, r =.36). There was a significant difference in scores between children who were identified with speech sound disorders on direct assessment (M = 3.85) and those who were not (M = 4.69) (d = -1.66).

Since that time, the ICS has been translated into 60 languages (http://www.csu.edu.au/research/multilingual-speech/ics), including Spanish *Escala de la Inteligibilidad en Contexto: Español* (McLeod, Harrison & McCormack, 2012c, Prezas, Rojas, & Goldstein, Trans.), *Turkish Bağlam İçi Anlaşılabilirlik Ölçeği: Türkçe* (McLeod, Harrison & McCormack, 2012d, Topbaş, Trans.), and Korean 특정 대화자 말명료도 척도: 한국어

(McLeod, Harrison & McCormack, 2012e, Kim, Trans.). Validation of the translated versions of the ICS has occurred for Traditional Chinese/Cantonese (Ng, To, & McLeod, 2014), Slovene (Kogovšek & Ozbič, 2013), and Croatian (Tomić & Mildner, 2014). For example, Ng et al. (2014) studied 72 Cantonese-speaking preschoolers and found that the ICS showed good internal consistency and test-retest reliability, and achieved sensitivity of 0.70 and specificity of 0.59 as the optimal cut-off estimated using Receiver Operative Characteristic (ROC) curve analysis. There was a significant difference in ICS scores between children who were identified on direct assessment with typical speech (M = 4.56) and those with speech sound disorders (M = 4.14) with a large effect size (d = 0.74). Additional studies are underway in a range of languages and countries around the world. The ICS has been used with children with typically developing speech (Kogovšek & Ozbič, 2013; Lagerberg, 2013, McLeod et al., 2012b; Ng et al., 2014; Tomić & Mildner, 2014), speech sound disorders (McLeod et al., 2012b; Ng et al., 2014), and cochlear implants (Thoroddsen, 2014). Despite the widespread interest in the use of the ICS, to date, normative studies have not been reported. The current study was designed to provide normative and additional validation data from English-speaking preschoolers for the ICS and to determine factors that affect the ICS score.

Aims of the Current Study

The aims of the current study were to report the normative data for Australian English-speaking preschool children's parent-reported scores on the ICS and examine the role of demographic, speech, and language variables. Additionally, the psychometric properties of the ICS were determined. Therefore, the specific questions asked were:

1. What are the mean scores for Australian English-speaking preschool children on the ICS based on demographic (age, sex, socioeconomic status) and speech and language (number of languages spoken, parental concern about talking and making speech sounds) variables?
2. Does the ICS demonstrate satisfactory internal consistency, test-retest reliability, and sensitivity and specificity?
3. Does the ICS demonstrate criterion validity via correlation with measures of speech severity on direct assessment?

Method

Recruitment of Participants

Data on the ICS were collected as part of the screening and assessment stages for the Sound Start Study, a 6-staged randomized controlled study to determine the effectiveness of a computerized intervention program (Phoneme Factory Sound Sorter, Wren & Roulstone, 2013). Data from stages 1 and 2 collected during years 1 and 2 of the study are reported in the current paper (see Figure 1). Fifty-four early childhood centers across the Greater Sydney region (Australia) were approached to participate in the Sound Start Study in years 1 and 2. A total of 33 early childhood centers consented to participate and distributed the Sound Start Study screening questionnaire to the parents of 1,353 4- and 5-year-old children attending these centers. Screening questionnaires were returned for 852 children (63.0%). Data were excluded for two children who were outside the target age range for the current study (48-65 months) when their parents completed the screening questionnaire. Data were further excluded for 47 children whose parents did not respond to one or more of the seven items of the ICS leaving a total of 803 children aged 48-65 months with complete ICS data. Figure 1 provides an overview of recruitment.

Insert Figure 1 about here

Participants

Participants were 803 English-speaking preschool children from Sydney, Australia. There were slightly more males (*n* = 419, 52.1%) than females (*n* = 384, 47.9%) in the sample (Table 1). The children were aged between 4;0 and 5;5 (*M* = 53.7 months; *SD* = 3.9). There were more children in the younger age groups (4;0-4;5, 4;6-4;11) than the older age group (5;0-5;5) reflecting the fact that most children commence school when they are 5 years old, although schooling is not compulsory in this Australian state until children are 6 years old. Family socioeconomic status was determined using the Australian Index of Relative Socioeconomic Advantage and Disadvantage (IRSAD, ABS, 2008) that is based on geographical location (zipcode/postcode). Socioeconomic advantage and disadvantage was described in deciles from most disadvantaged (1) to most advantaged (10) in terms of "people's access to material and social resources, and their ability to participate in society" (ABS, 2008, p. 17). IRSAD deciles of participants ranged from 1-10 with a mean of 6.2 (*SD* = 3.1) and mode of 10 (25^{th} percentile = 4, 50^{th} percentile = 6, 75^{th} percentile = 9). Information about family socioeconomic status was not available for four participants.

All children (*n* = 803) were reported to use English at home and/or at their early childhood center. The majority of parents described their children as using English "very well" (*n* = 550, 68.5%), with fewer parents reporting "somewhat well" (*n* = 178, 22.1%), or "not very well" (*n* = 58, 7.2%). There were 17 parents (2.1%) who did not respond to this question. Children were reported to use one (*n* = 506, 63.0%), two (*n* = 270, 33.6%), three (*n* = 25, 3.1%), or four (*n* = 2, 0.2%) languages with 59 languages reported in total. The most frequently spoken languages after English were: Arabic (*n* = 43), Korean (*n* = 21), Hindi (*n* = 19), Urdu (*n* = 18), Cantonese (*n* = 14), Mandarin (*n* = 14), Spanish (*n* = 13), Italian (*n* = 12), Indonesian (*n* = 11), Greek (*n* = 10), Vietnamese (*n* = 10), Serbian (*n* = 9), Punjabi (*n* = 8), Tagalog (*n* = 8), Bengali (*n* = 7), Japanese (*n* = 7), Samoan (*n* = 7), Tamil (*n* = 7), Chinese (not specified) (*n* = 6), Thai (*n* = 6), and Filipino (*n* = 5) with 37 additional languages being spoken by fewer than five children.

Parents were asked to report concerns about their children's communication development. Parents reported that they were concerned about their children's talking or production of speech sounds for 278 children (34.7%), speech not being clear to family for 107 children (13.3%), and speech not being clear to others for 191 children (23.8%). Parents indicated that a few children had a condition that could impair their speech development: persistent hearing loss (*n* = 15, 1.9%), cleft lip and/or palate (*n* = 4, 0.5%), and developmental delay (*n* = 28, 3.5%). These children were included in the normative data provided in this paper in order to provide a complete dataset (Peña, Spaulding, & Plante, 2006).

Insert Table 1 here

Representativeness of the sample compared with Australian children

The characteristics of the 803 parents and children described in this study were compared to participants in the Longitudinal Study of Australian Children (LSAC) Kindergarten cohort (McLeod & Harrison, 2009) for the purpose of examining the representativeness of the current sample. The children from the LSAC study are described as two comparison groups (1) 4,386 children aged 4- to 5-years, and (2) a sub-cohort of 3,383 of these children who attended preschools or childcare (see Table 2). The Sound Start Study had a similar male:female ratio to the LSAC study for children who attended preschool or childcare (Sound Start Study males = 52.2%; LSAC childcare males = 52.7%) . The average age of the children in the Sound Start Study (53.7 months) was younger than the LSAC samples (57.6, 57.0 months). There were a larger number of children who spoke a language other than English in the Sound Start Study (19.2%) compared with the LSAC samples (9.4%, 8.8%); reflecting the higher concentration of multilingual speakers in Sydney compared with the rest of Australia. In the whole sample of the Sound Start Study, there was a greater concern among parents about their children's talk and speech sounds (35.0%) than in the LSAC samples (24.9%, 25.6%).

Insert Table 2 about here

Children's parents.

Reports on children's speech intelligibility and development were provided by caregivers of the children (*N* = 803). The majority of respondents were parents: 696 (86.6%) mothers and 89 (11%) fathers. The remaining respondents were grandmothers (*n* = 2, 0.2%), aunts (*n* = 1, 0.1%), and cousins (*n* = 1, 0.1%), with 14 (1.7%) respondents not disclosing their relationship with the child. The term *parent* will be used throughout to refer to children's caregivers. The majority of parents completed the written screening questionnaire independently (*n* = 784, 97.6%), while a few completed the questionnaire orally with a researcher (*n* = 19, 2.3%).

Instruments

Intelligibility in Context Scale (ICS).

The ICS (McLeod et al., 2012a) is a seven item parent report measure of children's speech intelligibility with communicative partners with different levels of authority and familiarity. Communicative partners include parents, immediate family, extended family, friends, acquaintances, teachers, and strangers. Parents are asked to estimate how much of their child's speech is intelligible to each interlocutor on a 5-point Likert scale: *always* (5), *usually* (4), *sometimes* (3), *rarely* (2), or *never* (1). As mentioned earlier, the ICS has been validated for use with a different sample of Australian English-speaking preschoolers (McLeod et al., 2012b) with established internal reliability, construct validity, sensitivity and criterion validity.

Parent Evaluation of Developmental Status (PEDS).

Parents completed the 10-item Parent Evaluation of Developmental Status (PEDS; Glascoe, 2000), a standardized and validated screening questionnaire addressing global development. Within this paper, parents' responses to the question "Do you have any concerns about how your child talks and makes speech sounds?" were considered. Parents were given the option of reporting *yes, a little,* or *no*, and the children were classified as having no parental concern about speech and language if their parents reported *no*. This decision was made to be consistent with previous studies that have used the PEDS questions for describing children's speech and language status (e.g., McLeod & Harrison, 2009; McLeod, Harrison, McAllister, & McCormack, 2013).

Diagnostic Evaluation of Articulation and Phonology (DEAP).

Children's speech was assessed using the Phonology subtest from the Diagnostic Evaluation of Articulation and Phonology (DEAP, Dodd, Hua, Crosbie, Holm, & Ozanne, 2002). The DEAP Phonology subtest is a 50-item single word task that samples consonants, vowels, and consonant clusters. The version published in 2002 provides normative data for British and Australian children. Three measures were generated for each child using the standard scoring procedure outlined in the DEAP manual: PPC, PCC, and PVC.

Procedure

During stage 1 of the Sound Start Study 803 parents were invited to complete a 2-page questionnaire containing questions about their children's speech, language, and general development. Two sections of the questionnaire included the ICS and the PEDS (Glascoe, 2000). Questionnaires were returned to the centers.

Approximately one month later, children who met inclusion criteria for stage 2 of the Sound Start Study (*n* = 197) were invited to participate in a direct assessment of their speech and language skills (see Figure 1). The purpose of the stage 2 assessments was to determine which children had phonologically-based speech sound disorders, so children were included if their parents indicated concern about how their child talked and made speech sounds. Children were included in stage 2 if their parents or teachers had concerns about how the child made speech sounds and if the child's speech was not clear to a family member and/or other people. Children were excluded if their parents reported the child had a persistent hearing loss, cleft lip/palate, or a developmental delay. Further, children were excluded if their proficiency in a language other than English was better than their proficiency in English.

The DEAP Phonology subtest (Dodd et al., 2002) was completed by 184 children during stage 2 assessments and PCC, PVC, and PPC were calculated from this subtest. In addition parents were invited to fill out a questionnaire in which they could complete the ICS twice: first describing their child's spoken English, and second describing their child's use of a language other than English (if appropriate; *n* = 31). Test-retest reliability was calculated for the 140 parents who completed the ICS in stages 1 and 2 describing their children's English intelligibility. The robustness of the ICS in English versus other languages was calculated for the 31 parents who completed the ICS in English and another language in stage 2.

Data analysis

Parents' responses on the ICS required coding using whole numbers. Occasionally parents checked the space between two options on the Likert scale (e.g., between *sometimes* [3] and *usually* [4]). In these cases, the lowest number was recorded (i.e., 3) to provide a more conservative estimate because the lower the score the lower the intelligibility. Data were analysed using IBM SPSS Statistics Version 22.0 (IBM, 2013). To report normative data, the mean scores were calculated using the whole sample for each item on the ICS. ANOVAs and regression models were used to examine the effect of compounding variables on parents' responses. The following analyses were based on stage 1 ICS questionnaires (n = 803): normative data (measures of central tenancy, variance), impact of age, sex, socioeconomic status, number of languages spoken, and parental concern about speech (ANOVA, Tukey), psychometric properties of internal consistency (Cronbach alpha), correlation between the items (Spearman's rho), sensitivity and specificity (using Receiver Operative Characteristic). Tests for criterion validity used matching data from stage 1 ICS and stage 2 PCC, PVC, and PPC (bivariate correlations). Test-retest reliability used matching data from stage 1 ICS and stage 2 ICS in English (n = 140; Spearman's rho). The correlations between ICS for English and other languages were based on stage 2 ICS questionnaires (n = 31) (Spearman's rho).

Results

Normative Data

Overall the mean average total score of 4.4 (SD = 0.7) was obtained for the whole sample (803 children) on the ICS scores (see Table 3). Parents' ratings of children's intelligibility differed by communication partners, being highest for themselves (M = 4.7), then for immediate family members (M = 4.5), friends (M = 4.4), teachers (M = 4.4), extended family members (M = 4.3), acquaintances (M = 4.2), and lowest for strangers (M = 4.0). Repeated measure ANOVAs with Greenhouse-Geisser correction indicated significant mean differences among the responses for different items of the scale (F (4.012, 3217.963) = 203.6, p <.001, η_p^2 = .203). Pairwise comparisons using Bonferroni correction showed that parents rated children's intelligibility as highest when speaking to themselves and second highest when speaking to immediate family members. Parents rated children's intelligibility as lowest when speaking to strangers and the second lowest when speaking to acquaintances (all p_s <.001).

Insert Table 3 here

Impact of Demographic, Speech, and Language Variables

Three demographic variables were considered to determine their effect on the parent reported ICS scores (*n* = 803): sex, age groups, and socioeconomic status.

Sex and age.

Analysis of Variance (sex * age groups; see Table 5) shows there were significant differences between the children's mean ICS score based on their sex (males vs. females: F (5,802) = 7.7, $p < .005$, $\eta_p^2 = .01$). In addition, there were significant differences between the children's ICS score based on their age groups (4;0-4;5, 4;6-4;11; 5;0-5;5: F (5,802) = 6.5, $p < .001$, $\eta_p^2 = .01$). However, the effect sizes (η_p^2) were very small, which may be an indication of the large sample size. Follow up Tukey tests indicated that females were rated significantly higher in their level of intelligibility than males ($p < .005$). Children aged 5;0 to 5;5 were rated significantly lower than the other two age groups ($p < .01$). The interaction between sex and age groups was not significant.

Socioeconomic status.

A one-way ANOVA was used to test the differences between socioeconomic status based on the IRSAD decile and children's mean ICS score for the 803 participants. There was no significant difference in parents' responses on the ICS based on socioeconomic status (F (9,789)

= 1.26, p = .27, η_p^2 = .01), which indicates the robustness of the ICS for describing children from different social backgrounds.

Speech and language.

Two speech and language variables were considered to determine their effect on the children's mean ICS score: parental concern about talking and making speech sounds and number of languages spoken by the children. First, the mean ICS scores were compared based on level of parental concern about talking and making speech sounds (n = 797) and the following mean ICS scores were obtained when parents answered *no* (M = 4.6, SD = 0.5), *a little* (M = 4.0, SD = 0.6), and *yes* (M = 3.8, SD = 0.8). Second, the mean ICS scores were compared based on the number of languages spoken by the children (n = 803) and the following mean ICS scores were obtained when parents answered *one language* (M = 4.4, SD = 0.7), *two languages* (M = 4.3, SD = 0.6), *three languages* (M = 4.3, SD = 0.5), and *four languages* (M = 4.1, SD = 0.0). The two speech and language variables were entered simultaneously in a regression model as the predictive variables, with the children's mean ICS score as the dependent variable. The results showed that only parental concern about talking and speech sounds significantly predicted children's ICS score (*Beta* = -.43, $p < 0.001$, r_p = -.43). The number of languages reported to be spoken at home (*Beta* = -.035, p = .27, r_p = -0.03) was not a significant predictor.

Correlations Between ICS for English and Other Languages

Thirty-one children in stage 2 spoke language(s) other than English and their parents completed the ICS twice: once about how the children were understood in English then how the children were understood in the other language. The other language(s) spoken by these 31 children were: Arabic, Auslan, Filipino, Greek, Hindi, Indonesian, Khmer, Korean, Malayalam, Maltese, Marathi, Maori (Cook Island), Punjabi, Samoan, Serbian, Sinhalese, Spanish, Tamil, Telugu, Tongan, Urdu. As for all participants in stage 2, these children's parents and/or teachers had concerns about how they talked and made speech sounds. There were moderate to high and significant correlations between parents' responses to ICS items (and ICS total scores) for their children speaking English and other languages ($p_s < .001$) for six of the seven items on the ICS. The correlation was non-significant on the item related to the teacher's understanding of the child. Specifically, the following correlations were observed for each item: parents (*r* = .51), immediate family (*r* = .67), extended family (*r* = .56), child's friends (*r* = .63), acquaintances (*r* = .54), teachers (*r* = .22), strangers (*r* = .64) and total scores (*r* = .58). These correlations suggest the robustness of the ICS because parents' rating of their children's intelligibility was not related to the language described. The non-significant correlation for parent-reported teachers' understanding of the child's language compared with the other communicative partners may reflect that early childhood education in Australia is typically conducted in English, so the teachers may not understand the child when speaking another language.

Psychometric Properties of the ICS

Internal consistency and correlation between the items.

Cronbach alpha was calculated (*n* = 803) in order to measure the internal consistency of the items (α = .94), indicating high internal consistency in parents' responses to the items of the scale. Bivariate nonparametric correlation analyses (Spearman's rho) for the seven item ICS showed moderate to high correlations (ranging from *r* = .51 to *r* = .85, $p_s < .001$) between the items (see Table 4). While most correlations are high, moderate correlations were observed between caregiver and strangers (*r* = .51) and caregiver and acquaintances (*r* = .57).

Insert Table 4 here

Criterion validity.

Criterion validity of the ICS was obtained for 183 children in stage 2 (i.e., those with parental concern about speech and language) who were assessed on the DEAP (Dodd et al., 2002). Criterion validity describes the degree of overlap between two tools that measure similar abilities (Gay, 1985; Messick, 1993). In this case the ICS was compared with children's scores of the PCC, PVC, and PPC on the Phonology subtest of the DEAP, an established and valid measure of speech severity (Dodd et al., 2002). Bivariate correlation analyses showed that the ICS mean score was positively correlated with PCC ($r = .24$, $p < .001$), PVC ($r = .30$, $p < .001$), and PPC ($r = .30$, $p < .001$). These significant low correlation coefficients provide some evidence that speech severity is linked with parental ratings of intelligibility on the ICS.

Test-retest reliability.

As explained above, 140 parents completed each of the seven items on the ICS Scale twice with a mean interval of 38.1 days ($SD = 26.5$) between administrations. Spearman correlations were calculated in order to obtain a measure of test-retest reliability. Results showed a strong correlation between the ICS mean score for parents' first ($M = 3.9$) and second ($M = 3.8$) completions of the ICS ($r = .75$, $p < .001$), and also moderate significant correlations for each item ($p_s < .001$), suggesting satisfactory test-retest reliability. The following correlations were observed for each item: parents ($r = .56$), immediate family ($r = .64$), extended family ($r = .64$), child's friends ($r = .64$), acquaintances ($r = .63$), teachers ($r = .62$), strangers ($r = .66$).

Sensitivity and specificity.

The mean ICS scores were examined to determine the ability to differentiate children who were identified by parents as having difficulty talking and making speech sounds and those who were not identified. Results showed that the ICS scores were significantly lower for the children whose parents had concerns ($M = 3.9$) compared with those whose parents did not have concerns (*M* = 4.6), (*t* (796) = 16.8, $p < .001$, Cohen's *d* = 1). The significant difference in the ICS mean scores for the two groups, as demonstrated by the non-overlap of their 95% confidence intervals and large effect size, indicates that ICS mean scores are effective in discriminating children who have and have not been identified as having difficulty talking and making speech sounds.

The optimal threshold value for sensitivity and specificity based on Euclidean distance was obtained for the current study. Satisfactory levels of sensitivity (.75) and specificity (.82) were determined at the coordinate point (Glascoe & Dworkin, 2008). Since the ICS is designed as a screening tool, the designated cutoff was selected to provide satisfactory sensitivity levels in order to identify children with potential speech sound disorders. Using Receiver Operative Characteristic (ROC) curve analysis, the adjusted cutoff was chosen to yield a satisfactory sensitivity level of .82, which resulted in a drop in specificity level to .58 as a tradeoff (see Figure 2). The corresponding cutoff ICS score for the adjusted sensitivity and specificity pair was 4.6. That means, if the ICS mean score of 4.6 was used as the cutoff, the number of children identified as having speech sound disorders versus typical speech development will be the closest to the diagnosis based on the direct assessment results.

Discussion

Parents of 803 Australian English-speaking preschool children completed the ICS and normative data were generated. The mean ICS score (out of a maximum of 5) across all children was 4.4. This can be interpreted as, on average, preschool children are usually to always intelligible when talking with a variety of communicative partners. Children were most intelligible to their parents, followed by immediate family members, friends, teachers, extended family members, acquaintances, and least intelligible to strangers.

Age, sex, socioeconomic status, number of languages spoken, and parent concern about talking and making speech sounds were hypothesized to affect the scores on the ICS. Factors that impacted children's mean ICS scores were: sex (higher for females), age (higher for children aged 4;6-4;11), and parental concern about talking and making speech sounds (higher if parents were not concerned). Factors that did not significantly impact children's intelligibility scores on the ICS were: socioeconomic status and number of languages spoken by children. While most of these findings were anticipated, two require further discussion: age and number of languages spoken. The children's mean ICS scores for each age group were: 4.3 (4;0-4;5), 4.4 (4;6-4;11), and 4.3 (5;0-5;5). As outlined in the description of the participants, Australian children typically commence school when they are 5 years old; however, the mandatory age to commence schooling is 6 years. Therefore, it is likely that the 5-year-old children attending early childhood centers in the current study were likely to be those who were not ready to commence schooling and whose parents and teachers believed would benefit from an additional year of preschool education. One reason that they may not be ready for school could relate to their communicative competence and this may be reflected in their significantly lower ICS mean scores.

Children who spoke languages other than English were considered in two ways in the current paper. First, the number of languages spoken by the children (range 1-4 languages) did not impact the mean ICS score. Second, parents of 31 children who spoke more than one language completed the ICS twice (English and their main other language), and there was no significant difference between their mean ICS scores on the two versions. These findings can be cautiously interpreted to suggest that the ICS may be appropriate for use with children in English-speaking countries who speak languages other than English. Two cautions regarding this interpretation are that parents were invited to rate intelligibility for both languages at the same time, and the children's speech and language status in their other language was not tested. However, studies in Cantonese, Slovenian, and Croatian provide preliminary evidence that the ICS may be a valid tool to use with non-English speaking children (Kogovšek & Ozbič, 2013; Ng et al., 2014; Tomić & Mildner, 2014).

The psychometric properties of the ICS were examined. The ICS demonstrated good internal consistency of the seven items (α =.94) and moderate to high correlations between items. Criterion validity was established with significant but low correlation coefficients between mean ICS scores and measures of speech severity (PCC, PVC, and PPC). Test-retest reliability was demonstrated by moderate significant correlations between each of the seven items for parents' first and the second completions of the ICS after a one-month interval. Sensitivity of .82 and specificity of .58 was established as the optimal cutoffs using ROC curve analysis.

Limitations.

The current study was conducted within 33 early childhood centers located across Sydney, a major city in Australia, providing data from a wide range of socioeconomic areas. Within Sydney, a larger number of children speak languages other than English than in most of the rest of the country (Verdon, McLeod, & McDonald, 2014). The population studied within the current paper differs from the general Australian population with a greater diversity of languages spoken, and a greater level of parental concern about speech and language status (see Table 2). As a result, the scores reported in the current paper are conservative. The normative data may underestimate scores that could be obtained by screening all children in early childhood centers across Australia. Therefore, if children from different locations are achieving a mean score that is lower than the present study, then they are likely to require further investigation of their speech and language status. Another limitation of the study was that the psychometric properties of the

ICS (criterion validity and test-retest reliability) were examined for children whose parents/teachers had concerns about their speech development (stage 2), and did not include children who were typically developing (excluded from stage 2). Consequently, there is a need for replication of this study within other countries, with participants of a broader age range, and to examine the psychometric properties of the ICS for typically developing children.

Clinical implications and conclusions.

The ICS is a promising measure of children's speech intelligibility in different contexts that is quick to administer and score and can be used as a primary screening measure via distribution to parents within early childhood centers. A previous validation study established psychometric properties for 120 4- to 5-year-old English-speaking children (McLeod et al., 2012b). The current paper provides additional validation of the psychometric properties on a larger sample of preschool children and the first normative data for English-speaking children. The significant correlations between the ICS and measures of speech severity (PCC, PVC, PPC) suggest that the ICS could be used to determine which children require additional in-depth assessment of their speech. The ICS provides insights for clinicians into children's every-day communicative experiences and links to the Activities and Participation components of the ICF-CY (World Health Organization, 2007). Previous studies have shown that the ICS can be used when working with children who speak languages other than English (e.g., Ng et al., 2014), and the current paper demonstrates that the number of languages spoken does not impact the mean ICS score and there is a moderate to high correlation between mean ICS scores when parents reported on English or other languages spoken by their children. The ICS may be a useful addition to English-speaking speech-language pathologists' screening protocols for young children to consider speech intelligibility in a range of communicative contexts.

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Table 1.

Age and Sex of the Participants (n = 803)

Age range	Range (months)	Mean (months)	SD (months)	Males *n*	Females *n*	*N*
4;0-4;5 (48-53 months)	48-53	50.4	1.8	200 (49.3%)	206 (50.7%)	406
4;6-4;11 (54-59 months)	54-59	56.1	1.7	175 (54.0%)	149 (46.0%)	324
5;0-5;5 (60-65 months)	60-65	61.1	1.2	44 (60.3%)	29 (39.7%)	73

Table 2.

Characteristics of the Sound Start Study Sample used in the Current Study (N = 803) and the Samples from the Longitudinal Study of Australian Children (LSAC) of 4- to 5-Year-Old Children

	Sound Start Study: Children with completed parent questionnaires (*n* = 803)		Nationally representative study (LSAC, B cohort wave 3) (*n* = 4,386)		Nationally representative study (LSAC, B cohort wave 3): Sub-sample of children who attended preschool or childcare center (*n* = 3,383)	
	n	%	*n*	%	*n*	%
Boys: girls	419 : 384	52.1% : 47.9%	2251:2135	51.3%:48.7%	1782:1601	52.7%:47.3%
Language other than English spoken at home	154	19.2%	413	9.4%	292	8.8%
Parental concern about how their child “talks and makes speech sounds” (yes/a little)[a]	278	35.0%	1093	24.9%	867	25.6%
Parental concern that their child’s “speech [is] not clear to family”	107	13.4%	256	5.8%	202	6.0%
Parental concern that their child’s “speech [is] not clear to others”	191	23.9%	603	13.7%	482	14.2%
	Mean	SD	Mean	SD	Mean	SD
Child age (months)	53.7	3.9	57.6	2.8	57.0	2.5

[a] This question was not responded to by six parents. Therefore valid data were available for 798.

Table 3.

Parent Responses for the Seven Item Intelligibility in Context Scale for the Total Sample (n = 803)

Question	Total		Range	Always (5)		Usually (4)		Sometimes (3)		Rarely (2)		Never (1)	
	M	(SD)		*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
1. Do you understand your child?	4.7	0.5	2-5	589	73.3	192	23.9	21	2.6	1	0.1	0	0.0
2. Do immediate members of your family understand your child?	4.5	0.6	1-5	488	60.8	261	32.5	49	6.1	4	0.5	1	0.1
3. Do extended members of your family understand your child?	4.3	0.8	1-5	381	47.4	302	37.6	103	12.8	16	2.0	1	0.1
4. Do your child's friends understand your child?	4.4	0.8	1-5	424	52.7	284	35.4	80	10.0	14	1.7	1	0.1
5. Do other acquaintances understand your child?	4.2	0.8	1-5	352	43.8	298	37.1	1290	16.1	18	2.2	6	0.7
6. Do your child's teachers understand your child?	4.4	0.7	1-5	397	49.4	320	39.9	69	8.6	15	1.9	2	0.2
7. Do strangers understand your child?	4.0	1.0	1-5	316	39.4	283	35.2	147	18.3	39	4.8	18	2.2
Average total score (max 35)	30.5	4.6											
Average total score (max 5)	4.4	0.7											

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., 2012a)

Table 4.

Correlations Between the Seven Items on the Intelligibility in Context Scale at Stage 1 (n = 803)

	1. Parent	2. Immediate family	3. Extended family	4. Child's friends	5. Acquaintances	6. Teachers	7. Strangers
1. Parent	-	.751**	.616**	.617**	.567**	.594**	.508**
2. Immediate family	.751**	-	.791**	.689**	.705**	.668**	.630**
3. Extended family	.616**	.793**	-	.760**	.848**	.738**	.772**
4. Child's friends	.617**	.689**	.760**	-	.786**	.760**	.719**
5. Acquaintances	.567**	.705**	.848**	.786**	-	.729**	.832**
6. Teachers	.594**	.668**	.738**	.760**	.729**	-	.742**
7. Strangers	.508**	.630**	.772**	.716**	.832**	.742**	-

Note. ***p* < .01

Table 5.

Mean and Standard Deviations for the Seven Item Intelligibility in Context Scale by Sex and Age (n = 803)

Age range	Sex	*n*	*Mean* (range 1-5)	*SD*
4;0-4;5	Male	200	4.3	0.7
	Female	206	4.3	0.6
	Total	406	4.3	0.7
4;6-4;11	Male	175	4.3	0.6
	Female	149	4.5	0.6
	Total	324	4.4	0.6
5;0-5;5	Male	44	4.2	0.8
	Female	29	4.4	0.6
	Total	73	4.3	0.7

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., 2012a)

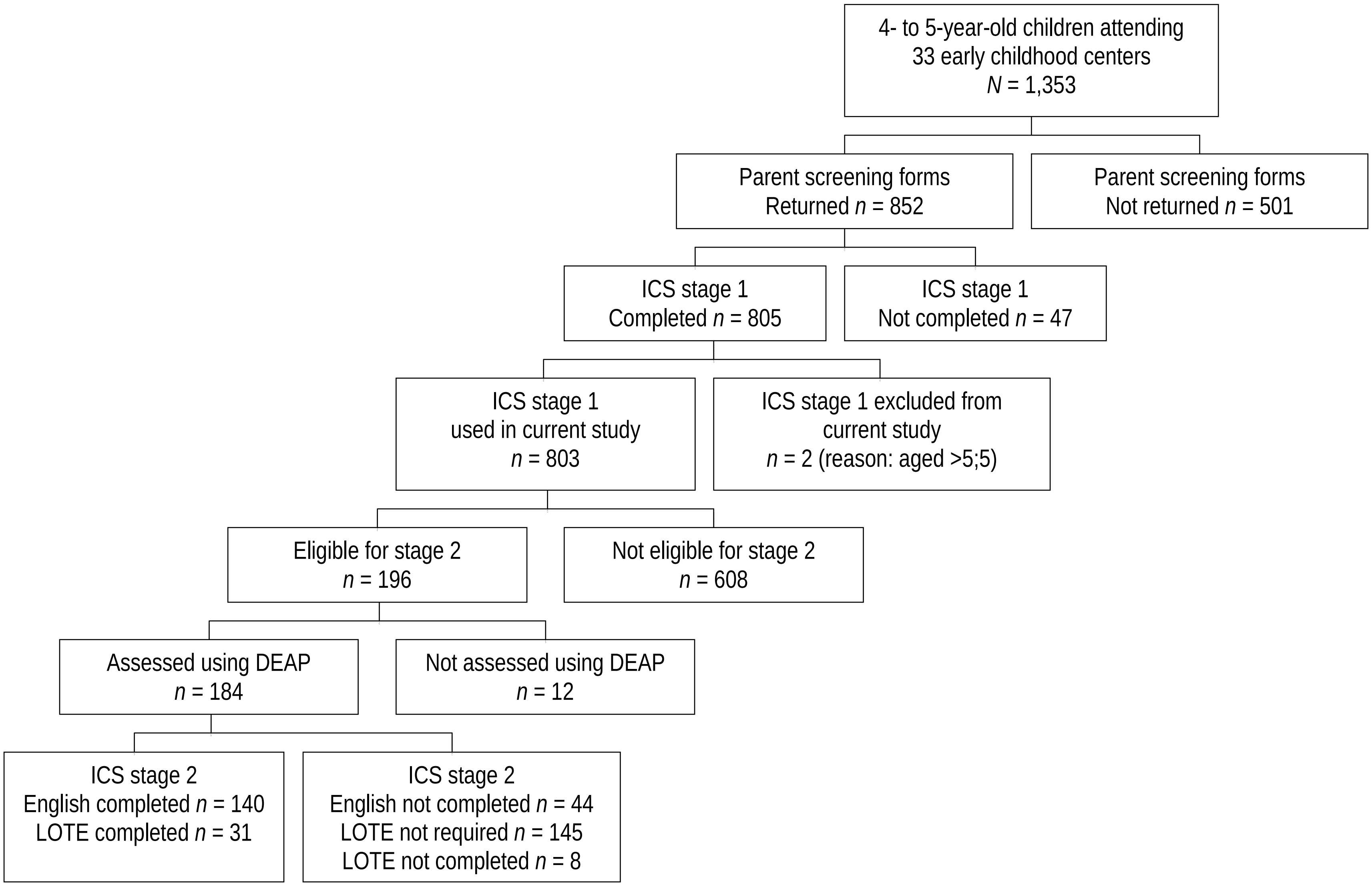
4- to 5-year-old children attending 33 early childhood centers N = 1,353
Parent screening forms Returned n = 852
Parent screening forms Not returned n = 501
ICS stage 1 Completed n = 805
ICS stage 1 Not completed n = 47
ICS stage 1 used in current study n = 803
ICS stage 1 excluded from current study n = 2 (reason: aged >5;5)
Eligible for stage 2 n = 196
Not eligible for stage 2 n = 608
Assessed using DEAP n = 184
Not assessed using DEAP n = 12
ICS stage 2 English completed n = 140 LOTE completed n = 31
ICS stage 2 English not completed n = 44 LOTE not required n = 145 LOTE not completed n = 8

Figure 1. Derivation of participants from the Sound Start Study Sample used in the present investigation. ICS, Intelligibility in Context Scale (McLeod et al., 2012a), DEAP, Diagnostic Evaluation of Articulation and Phonology (Dodd et al., 2002), LOTE, language other than English. Stage 1 refers to the first stage of the Sound Start Study (where all children were screened as outlined in the method), and the parents' first completion of the ICS. Stage 2 refers to the second stage of the Sound Start Study (where only children with possible speech sound disorders were assessed) and the parents' second completion of the ICS.

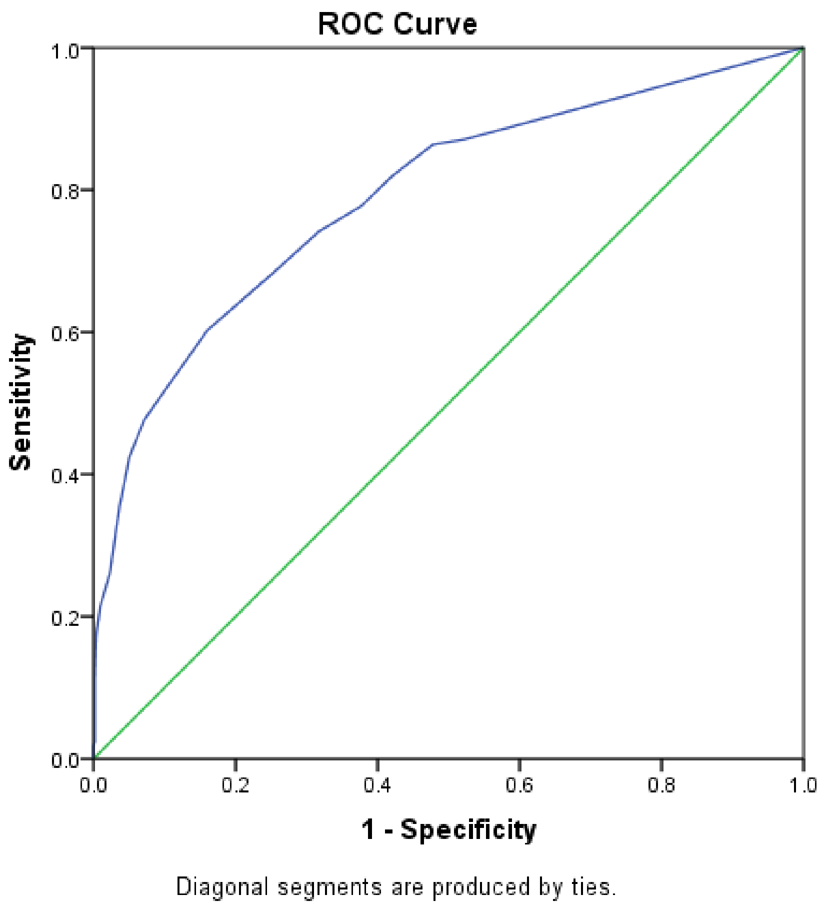

Figure 2. Receiver Operative Characteristic (ROC) curve analysis to estimate the optimal sensitivity and specificity cutoff.