Volume 15 Article 2, January 2022

EBP briefs

A scholarly forum for guiding evidence-based practices in speech-language pathology

Assessment of Speech Sound Disorders in Children: Considerations for Telepractice

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EBP Briefs

Cite this document as:
Masso, S., & Thomas, D. (2022). Assessment of speech sound disorders in children: Considerations for telepractice. *EBP Briefs, 15*(2), 1–6. NCS Pearson, Inc.

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Structured Abstract

Clinical Question: When assessing children's speech using a standardised speech assessment, is face-to-face better than telepractice to determine the presence and the nature of speech sound disorder?

Method: Systematic Review

Study Sources: PsycInfo®, CINAHL, Scopus, PubMed, ERIC

Search Terms: telehealth OR telepractice OR telemedicine AND child AND speech

Number of Included Studies: 5

Primary Results: Conducting screening and assessment of children's speech sound development via telepractice may be appropriate, and comparable, to an assessment conducted in a traditional face-to-face setting. Ratings of intelligibility were comparable when completed in telehealth and face-to-face conditions (Waite et al., 2012) but some aspects of oral musculature assessment (OMA) screening may be less reliable when completed via telepractice. Similarly, high levels of agreement were reported during the comprehensive sampling of children's speech via telepractice or face-to-face. However, agreement between specific consonant errors was less accurate (Jessiman, 2003). Utilising a lapel microphone and ensuring good lighting and optimum camera positioning may increase the accuracy of speech assessments conducted via telepractice.

Conclusions: Screening and standardised assessments of children's speech can be conducted successfully via telepractice when the SLP considers and plans for several factors, including: the nature of the data being collected (e.g., ratings of intelligibility, judgments of phoneme correctness, errors present in children's speech); the equipment available to support high-quality audio, video, and recording; and the other information collected about the child as a part of a comprehensive assessment. Recording the assessment task(s) will support review of transcription and analysis.

Assessment of Speech Sound Disorders in Children: Considerations for Telepractice

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Clinical Scenario

Daniel is a paediatric speech-language pathologist (SLP) in Sydney, Australia. He works in a private practice and usually sees families in his clinic rooms for 30- to 45-minute face-to-face sessions. When COVID-19 restrictions affected his practice in early 2020, he wanted to know how to do his practice online, via telepractice. Although Daniel could continue seeing children in his rooms, many families were nervous about coming to face-to-face sessions and preferred to see him online. Daniel has an assessment scheduled with Alice, a 4-year-old girl who attends preschool in the local area. He needs to decide whether he can conduct a valid and reliable assessment with Alice via telepractice or whether he needs to see her in his clinic.

Daniel contacted Alice's mother to ask her preference for Alice's assessment; Alice's mother indicated that she did not want to attend in person and would prefer to do the assessment via telepractice. Daniel completed a brief screening of Alice's intake information with her mother. Alice had been a late talker and had previously seen an SLP for language intervention (ages 2–3 years). Alice had not seen an SLP in the previous 6 months. Her mother was primarily concerned about Alice being understood by the educators at her preschool. Alice's immediate family could understand her most of the time but her extended family and adults in her preschool frequently had difficulty understanding her. Her mother had visited her local general practitioner and he had referred her for a government-subsidized, speech-language pathology assessment as a part of the Australian government's Chronic Disease Management program. Now, Daniel needed to determine whether he could adequately complete her assessment via telepractice or whether he had to insist that Alice and her mother attend in person to complete a valid assessment.

Background Information

Children in Australia can access speech-language pathology services if they require communication support. However, the availability of services may differ according to geographical area with specific service limitations in some rural and remote areas (McCormack & Verdon, 2015; Verdon et al., 2011). Traditionally, allied health services have required in-person attendance but recent investigations have explored the barriers and facilitators to accessing speech-language pathology services via telepractice (Campbell et al., 2019). Telepractice[1] can be defined as "an interaction between a health care provider and a patient when the two are separated by distance" (World Health Organization, 2016, p. 56). The primary challenge in providing telepractice services with children is ensuring the validity and reliability of the service.

Standardised and norm-referenced assessments are typically the gold standards for the diagnosis of speech sound disorders (SSDs). Some speech assessments function to determine the presence (or absence) of speech errors that are not developmentally typical for the child's age (e.g., the Goldman-Fristoe Test of Articulation™ [2nd ed.; GFTA™-2]; Goldman & Fristoe, 2000), whereas others are designed to support the differential diagnosis of articulation difficulties distinct from patterns of phonology errors and/or inconsistency (e.g., the Diagnostic Evaluation of Articulation and Phonology; Dodd et al., 2006). For some children, a dynamic assessment may be most appropriate to support differential diagnosis of different types of SSDs (e.g., using the Dynamic Evaluation of Motor Speech Skill; Strand & McCauley, 2019). Regardless of the tool used, the assessment needs to be valid *and* reliable to determine the presence or absence of developmentally appropriate speech sound errors. Validity refers to the "degree to which the assessment fulfills its intended purpose" (Sireci & Sukin, 2013, p. 61) and includes consideration of the test design as well as the interpretation of test scores. Reliability is

[1]Telepractice may also be referred to as telehealth, telemedicine, or eHealth in different clinical areas.

the degree of certainty that two independent evaluators would achieve the same clinical information from a test (Bech, 2012).

Clinical Question

Daniel's rapid transition to telepractice with his clinical caseload made him consider the evidence for assessments conducted via telepractice compared to those completed in traditional, face-to-face assessment contexts. To structure his question, Daniel considered the clinical problem through the framework of a PICO question (Straus et al., 2018). A PICO question traditionally considers four aspects of the clinical problem: (1) the population (P), (2) the intervention (I), (3) the comparison group (C), and (4) the outcome (O). Because Daniel was interested in assessment rather than intervention, he adopted a broad definition of the intervention component of his question to include the assessment being utilised for his population of interest. This definition of intervention for the purposes of a PICO question is consistent with PICO definitions that consider intervention as "defined very broadly, including an exposure, a diagnostic test, a prognostic factor, a treatment, a patient perception . . ." (Straus et al., 2018, p. 21). Thus, Daniel's PICO question was:

P – children with suspected SSD

I – assessed face-to-face for speech production accuracy using standardised assessment tools

C – in face-to-face contexts compared to telehealth/ telepractice

O – to determine the presence and the nature of SSD

Therefore, Daniel's clinical question was: When assessing children's speech using a standardised speech assessment, is face-to-face better than telepractice to determine the presence and nature of the speech sound disorder?

Search for the Evidence

Daniel was interested to explore the evidence for the effectiveness of assessments of speech disorders via face-to-face interactions versus via telepractice. He decided to try an online tool, Covidence (covidence.org), to help him with his search. Covidence is software to help manage a systematic review (no matter how small). Daniel was able to use a free trial version of this tool because he had fewer than 500 papers captured in his search[2]. Daniel thought that Covidence might help him keep track of the papers he found as a part of his systematic review. Once he established that he would use Covidence, Daniel settled on the search strategy (including search terms and databases he would search) as well as the inclusionary and exclusionary criteria for papers he would review. His inclusionary criteria were studies that: (1) were conducted with children under 18 years old, (2) included the assessment of children's speech in a telepractice format, and (3) included a comparison with face-to-face data gathered from children. Excluded papers were those that: (1) only reviewed literature or provided a commentary on the issue of telepractice assessment without presenting any direct data, (2) were not published in English, or (3) were not peer reviewed. To capture relevant papers, Daniel established three primary search term categories: (1) telepractice (including "telehealth," "telepractice," and "telemedicine"), (2) child (to capture the population of interest), and (3) speech (to capture papers related to speech assessment). He decided to search five large journal databases to capture as many papers as possible in the areas of medicine, education, and allied health. His search strategy is presented in Table 1.

After Daniel completed his search across each of the five databases, he had identified 256 papers (see Figure 1). Covidence identified 56 duplicate papers, and Daniel reviewed the title and abstract of the remaining 200 papers. From the review of the titles and abstracts, Daniel identified 21 papers that he wanted to read in full to determine eligibility. After scanning the full text of all 21 papers, he found that most (n = 17) did not meet his inclusionary criteria (see Figure 1). He did, however, find four papers that were suitable to include in his review (Ciccia et al., 2011; Eriks-Brophy et al., 2008; Waite et al., 2006; Waite et al., 2012). Daniel then reviewed the reference lists of all four papers to check for any additional papers that may not have been captured in his database search. This hand search of the reference lists yielded one additional study (Jessiman, 2003) that met his inclusion criteria. In addition to the papers, Daniel also identified a systematic review of evidence for assessing children's speech and language via telepractice (Taylor et al., 2014). This previous systematic review would help him evaluate the available evidence for children with SSDs in the context of broader speech and language assessment.

[2] At the date of writing (February 2021), a free trial version of Covidence is available at covidence.org. The free trial is only available for reviews that require the screening of fewer than 500 citations with a maximum of two reviewers. For reviews that require the screening of more citations and/or more reviewers, a paid version of the software is required.

Evaluating the Evidence

Daniel decided to review the five papers captured from his systematic search as well as the systematic review he found by Taylor and colleagues (2014). The five assessment papers all included an evaluation of children's speech through administration of test items via telepractice as well as a real-time face-to-face assessment of children's speech. Daniel decided to review each of the articles for methodological quality as well as the research design, population of interest, assessment(s) used, equipment used, and the outcome (see Table 2). Daniel wanted to review the quality of the research design for each of the papers and used the Oxford Centre for Evidence-Based Medicine (2011) Levels of Evidence as a guide for rating this quality. The papers that Daniel found did not meet any of the question standards in the Oxford Levels of Evidence (i.e., the studies were not diagnostic, prognostic, intervention, or screening studies). For this reason, Daniel established two factors that would support his evaluation of quality: (1) the timing of scoring reported by each study (i.e., simultaneous scoring online, nonsimultaneous scoring from a recorded sample of individual children, nonsimultaneous scoring from different recorded samples from the same children, or nonsimultaneous scoring of different samples from different children) and (2) randomisation of children or assessor to assessment condition (see Table 2). These factors allowed him to differentiate between studies that replicated his own clinical context (i.e., reviewing the accuracy of scoring from a single sample) and reduced bias compared to studies that did not consider these factors.

The available evidence explored two types of speech sampling: (1) speech sampling for the purposes of screening children's speech with a short word list (Ciccia et al., 2011) or intelligibility rating (Waite et al., 2012), and (2) comprehensive sampling of speech development with published tests (Eriks-Brophy et al., 2008; Jessiman, 2003) and unpublished tests (Waite et al., 2006).

Screening Speech Production via Telepractice

Two of the studies Daniel found attempted to screen children's speech via telepractice. The first study, Ciccia and colleagues (2011), used pass/fail criteria on age-appropriate screening tasks to explore the reliability of screening via telepractice in children under 5 years of age. Unfortunately, reporting in the Ciccia and colleagues study was limited and the children in the comparison face-to-face group were different than those screened via telepractice. Therefore, although Ciccia and colleagues described reliability of speech screeners as 100% reliable, the team did not explain the way this calculation was determined. The second study (Waite et al., 2012) screened speech production through intelligibility rating of a connected speech task supplemented by an oral musculature assessment (OMA). In Waite and colleagues' (2012) study, two groups of children were randomly allocated to face-to-face or online test administration of assessment tasks. A connected speech task was conducted for the purpose of determining intelligibility on a scale of 1–5; intelligibility ratings were compared between two raters (one online and one in the room with the target child). The informal OMA screener also used a 5-point rating scale. Recordings of the participants' performance were available for review by both the online and face-to-face assessor to assist with their judgements. The clinicians and participants in Waite and colleagues' (2012) study used microphones and headphones. Similar to Ciccia's study, Waite and colleagues (2012) reported high levels of agreement for intelligibility ratings. Although high levels of overall agreement on the OMA screener was found, there was poor to fair agreement for judgments of tongue movement and diadochokinesis (DDK) tasks. The telepractice condition resulted in similar interpretation of children's speech intelligibility and oral musculature.

Comprehensive Speech Sampling via Telepractice

Three of the studies that Daniel identified described comprehensive assessments to sample children's speech accuracy (Eriks-Brophy et al., 2008; Jessiman, 2003; Waite et al., 2006). Combined, these studies reported assessments that were completed with 13 children who were ages 4:3–12:9 years old and used at least two different video conferencing systems (Jessiman [2003] utilised the Regional Satellite Based Telepractice system whereas Waite and colleagues [2006] used eRehab). Only one of the studies indicated that the children wore a lapel microphone during their assessment (Jessiman, 2003). All three studies included single-word tests, either norm-referenced (e.g., GFTA-2 [Goldman & Fristoe, 2000] used by Eriks-Brophy et al., 2008) or informal (Waite et al., 2006); one study added a connected speech sample and OMA (Waite et al., 2006). All studies investigated the agreement between a local assessor and an assessor who evaluated the child via telepractice;

two of the studies considered evaluation of one child from a single recorded sample (Eriks-Brophy et al., 2008; Waite et al., 2006) and the third study compared a telepractice assessment with a face-to-face assessment conducted 3 days later (Jessiman, 2003).

Daniel noticed that each of the three studies reported some disagreement between a face-to-face assessor and telepractice assessor in evaluating consonant accuracy. At times, the disagreement between assessors' perceptions led to large difference in standard score on a norm-referenced tool (i.e., 12 points on the GFTA-2; Eriks-Brophy, 2008). Jessiman (2003) identified that there was high agreement in reporting the accuracy of consonants between telepractice and face-to-face assessments but decisions about specific speech errors was less accurate. The studies determined that evaluating the accuracy of fricatives, affricates, unvoiced consonants, and /s/ clusters may be more difficult when evaluating a child's speech accuracy via telepractice. Jessiman (2003) did, however, report that agreement between face-to-face and telepractice assessment results increased when children wore a lapel microphone. In terms of the OMA component of an assessment, excellent reliability was obtained for oral structure and single oral movements, with fair reliability for double oral movements (Waite et al., 2006).

Assessing Speech Sounds in the Context of Wider Communication Impairment

The systematic review conducted by Taylor and colleagues (2014) identified that there is good evidence to support the validity of speech, language, and oromuscular function tasks via telepractice. However, reliability of data gathered for OMAs may be reduced if the assessment is conducted via telepractice (Waite et al., 2006; Waite et al., 2012). Two key factors affecting reliability of an OMA were the positioning of the camera and having adequate light (Waite et al., 2006). For this reason, and many others, several of the studies recommended movable webcams and/or a facilitator at the participant's site to assist with camera angle (Ciccia et al., 2011; Waite et al., 2006; Waite et al., 2012).

Other assessment factors that are not impacted by administration via telepractice include gathering comprehensive data regarding the child's: (1) case history, demographic information, developmental milestones, medical history and parental communication concerns, (2) parent-report measures of intelligibility (e.g., the Intelligibility in Context Scale; McLeod et al., 2012) or developmental screening (e.g., the Communication and Symbolic Behaviour Scales Developmental Profile™, Infant-Toddler Checklist; Wetherby & Prizant, 2002), and (3) language exposure (e.g., Babylab Language Exposure Questionnaire; Cattani et al., 2014).

The Evidence-Based Decision

To make an evidence-based decision, Daniel considered the three elements of the evidence-based practice framework (E^3BP) described by Dollaghan (2007): (1) external evidence from the published literature, (2) internal evidence from his own clinical practice, and (3) the preferences of Alice's family. In terms of external evidence, Daniel noted mixed findings. Although the telepractice modality was appropriate for case history and detecting a speech sound disorder, there was mixed reliability for oral musculature assessments and identification of specific phonemes, particularly if lighting was sub-optimal or a lapel microphone was not used. In terms of Daniel's own expertise, he was experienced with face-to-face assessments for SSD but had not previously used telepractice. Finally, in terms of the parent/family preference, Daniel noted Alice's mother's preference for a telepractice assessment. Considering all the evidence available, Daniel decided to move forward with Alice's assessment via telepractice. He made this decision for three primary reasons: (1) he was now informed of several ways he could increase the reliability of the assessment based on evidence he found in the literature; (2) he was confident in his clinical abilities to engage Alice, conduct an assessment, and acknowledge if/when further face-to-face assessment may be required; and (3) he was aware of Alice's mother's preference for a telepractice assessment.

Daniel decided to collect a comprehensive case history, oromuscular assessment, single-word sample, and connected speech sample. Daniel aimed to improve the validity of his assessment by using a single-word assessment that is familiar to him. He selected the Goldman-Fristoe Test of Articulation 3 (GFTA–3, Goldman & Fristoe, 2015) that he had used many times before. Resources for the GFTA–3 are available for use via telepractice (via Q-global®, Pearson), and his familiarity with the test items and administration supported the interpretation of Alice's speech. He wore an integrated microphone and headphone headset to reduce feedback for Alice and help him hear her speech. He collected a 10-minute connected speech sample to evaluate Alice's intelligibility and rated her intelligibility on the 5-point scale described by Waite and colleagues (2012).

Given the challenges accurately transcribing children's speech via telepractice, Daniel asked Alice's mother to locally record her speech sample and upload it to a secure cloud-based server. As a backup, he also planned to use the inbuilt recording function in his videoconferencing software to record the session in case Alice's mum was unable to record and/or upload the sample. He knew that audio quality may be improved if Alice used a microphone and asked her mum whether the family had a lapel microphone or integrated headphone/microphone headset. Because they had neither, he recommended purchasing a microphone. For a young child like Alice, he recommended a lapel microphone so that he could hear Alice clearly and her mum could hear the session via the computer's in-built speakers. He asked Alice's mum to assist during the assessment—to adjust the webcam angle, sound settings, and lighting—to ensure that Alice's face could be seen clearly. Because of his evaluation of the evidence, he was particularly careful to listen for fricatives, affricates, unvoiced consonants, and /s/ consonant clusters (Eriks-Brophy et al., 2008; Jessiman, 2003). He was confident that he would be able to determine the presence or absence of a speech sound disorder based on information collected in Alice's telepractice assessment.

Authors' Note

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Table 1. Daniel's Search Strategy

Databases searched	Search terms
PsycInfo (American Psychological Association) Cumulative Index to Nursing and Allied Health Literature (CINAHL) Scopus PubMed Education Resources Information Center (ERIC)	telehealth OR telepractice OR telemedicine AND child AND speech

Table 2. Studies Identified That Met Daniel's Inclusion Criteria

Study	Population	Location	Speech assessment tools	Assessment condition	Scoring	Equipment used for telepractice	Outcome of comparison	Quality evaluation	
								Scoring	Randomisation
Ciccia, Whitford, Krumm, & McNeal (2011)	263 children [telepractice]; 10 children [face-to-face]	Cleveland, Ohio, USA	REEL–3 (for children < 2:6 years); PLS™-4 (for children 2:6–4:0 years)	Telepractice or face-to-face	Pass/fail criteria	Skype used on Dell laptops with Microsoft webcam.	Different children were in each group. Reliability was reported to be 100% but process not described.	Nonsimultaneous scoring of different children	No
Eriks-Brophy, Quittenbaum, Anderson, & Nelson (2008)	Five children (ages 4:3–12:9 years)	Ontario, Canada	GFTA-2	Telepractice only	Accuracy and errors scored	Video-conferencing system (software not reported)	Local SLP was more likely to identify speech error than online SLP. Disagreements were "primarily unvoiced phonemes, consonant clusters, and production of fricatives" (p. 600).	Simultaneous scoring	No
Jessiman (2003)	Two children (ages 7:0 and 5:4 years)	Northern Alberta, Canada	Structured Photographic Articulation Test	Telepractice first; repeated face-to-face 3 days later	Accuracy and errors scored	RSBT system with and without lapel microphone	Fricatives, affricates, and s-clusters were less reliable. Accuracy could be determined (correct vs. incorrect) but phoneme substitution/ distortion was more difficult.	Nonsimultaneous scoring of the same children (two different samples)	No
Waite, Cahill, Theodoros, Busuttin, & Russell (2006)	Six children (ages 4:3–6:8 years)	Queensland, Australia	Single-word articulation test (list not provided); connected speech sample	Telepractice administration only (local clinician scored face-to-face)	Target consonant accuracy scored. Intelligibility rating (1–7 scale)	eRehab video-conferencing	Total agreement was high for all consonants. Lowest agreement was established on /l/ word-final, /ʧ/ initial and final, /ʒ/ medial, /g/ final, and /p/ initial).	Nonsimultaneous scoring from recorded sample (one sample)	No
Waite, Theodoros, Russell, & Cahill (2012)	10 children [telepractice]; 10 children [face-to-face] (ages 4–9 years)	Queensland, Australia	Connected speech sample	Telepractice or face-to-face	Intelligibility rating (1–7 scale)	eRehab incl. headphones and microphone	High levels of agreement for ratings of intelligibility between local and online SLPs.	Nonsimultaneous scoring from recorded sample (one sample)	Yes

Note. GFTA-2 = Goldman-Fristoe Test of Articulation (2nd ed.); PLS-4 = Preschool Language Scale (4th ed.), (Zimmerman, Steiner, & Pond, 2002); REEL–3 = Receptive–Expressive Emergent Language Test (3rd ed.); RSBT = Regional Satellite Based Telehealth; Structured Photographic Articulation Test.

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Diagram of Study Screening and Full Text Review