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Review

Computer-based speech therapy for childhood speech sound disorders

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ABSTRACT

Background: With the current worldwide workforce shortage of Speech-Language Pathologists, new and innovative ways of delivering therapy to children with speech sound disorders are needed. Computer-based speech therapy may be an effective and viable means of addressing service access issues for children with speech sound disorders.
Aim: To evaluate the efficacy of computer-based speech therapy programs for children with speech sound disorders.
Method: Studies reporting the efficacy of computer-based speech therapy programs were identified via a systematic, computerised database search. Key study characteristics, results, main findings and details of computer-based speech therapy programs were extracted. The methodological quality was evaluated using a structured critical appraisal tool. Main contribution: 14 studies were identified and a total of 11 computer-based speech therapy programs were evaluated. The results showed that computer-based speech therapy is associated with positive clinical changes for some children with speech sound disorders.
Conclusions: There is a need for collaborative research between computer engineers and clinicians, particularly during the design and development of computer-based speech therapy programs. Evaluation using rigorous experimental designs is required to understand the benefits of computer-based speech therapy.
Learning outcomes: The reader will be able to 1) discuss how computerbased speech therapy has the potential to improve service access for children with speech sound disorders, 2) explain the ways in which computer-based speech therapy programs may enhance traditional tabletop therapy and 3) compare the features of computer-based speech therapy programs designed for different client populations.

1. Introduction

Children with speech sound disorders (SSD) constitute more than 40% of the caseload of Speech-Language Pathologists (SLPs) (e.g. Joffe & Pring, 2008; McLeod & Baker, 2014). With the current workforce shortage of SLPs (e.g. Edgar & Rosa-Lugo, 2007; Health Workforce Australia, 2014), computer-based speech therapy could help to address service access issues, particularly for families living in rural and remote areas. A number of computer-based speech therapy programs have been developed to address SSD, however few are supported by empirical evidence of clinical efficacy. The purpose of this narrative review is to evaluate the current state of the literature reporting on the efficacy of computer-based speech therapy programs for children with SSD.

To effect change, children with SSD benefit from intensive and frequent therapy sessions (Baker & McLeod, 2011). While optimal

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treatment intensity for children with SSD is not known, it has been suggested that 30–40 sessions may be required, depending on the severity of the SSD and elected treatment approach (Williams, 2012). High intensity treatment (Williams, 2012) over a long period of time (Timko & Moos, 2002) may be beneficial for children with severe SSD. Providing intensive intervention can sometimes be challenging due to financial, logistical and geographical constraints (Saz et al., 2009; Togher, 2012). This was shown in a questionnaire by To, Law, and Cheung (2012). Factors such as caseload size influenced the frequency and duration of treatment sessions provided to children with SSD. Respondents (102 SLPs) with larger caseloads reported shorter and less frequent therapy sessions. This was despite reports that child and family-related factors were foremost considerations when determining treatment intensity (To et al., 2012). Up to 70% of SLPs have waiting lists (McLeod & Baker, 2014) which can slow access to services. This potentially increases a child's risk of social, emotional and academic difficulties (e.g. Lewis, Freebairn, & Taylor, 2000; McCormack, McLeod, Harrison, McAllister, & Holliday, 2010).

Computer-based speech therapy as a service delivery model may reduce the influence of client, clinician and service-related variables on optimal treatment intensity. For example, adherence to high session frequency or extended duration of intervention may be difficult for some families due to financial constraints or their distance to speech pathology services (Baker, 2012). Supplementing face-to-face therapy sessions with computer-based speech therapy would allow these clients continued and convenient access to therapy tasks (Massaro & Light, 2004; Wren, Roulstone, & Williams, 2010). Depending on the features of the computer-based speech therapy program, these tasks may be accessed as frequently as desired. This means that treatment intensity can be increased. There is potential for clients to reach expected outcomes earlier yet without the need for simultaneous increased direct contact time with a SLP (Finch, Clark, & Hill, 2013; Massaro & Light, 2004; Nordness & Beukelman, 2010). In some cases the total duration of rehabilitation could be extended using computer-based speech therapy (Wren et al., 2010).

The use of computers in speech-language pathology has previously been referred to as computer-based interventions (Wren et al., 2010), computer-based speech therapy (Engwall, Bälter, Öster, & Kjellström, 2006) and computer-aided speech and language therapy (Saz et al., 2009). Just as there is no single term to refer to the use of computers in speech-language pathology, there is also no complete or comprehensive definition of 'computer-based speech therapy.' For the purposes of focussing this review and selecting studies for inclusion, the following definition is provided: a computer-based speech therapy (CBST) program is software offering predefined therapy tasks inclusive of instructional features (e.g. an animated talking tutor, the use of synthesised speech to provide models or instructions), motivational features (e.g. the use of animations, game-based activities) and quantitative features (e.g. tracking of performance within and across therapy sessions) (Shriberg, Kwiatkowski, & Snyder, 1989), operating from a personal computer. Visual feedback technologies such as ultrasound, electropalatography and glossometry that solely give a computerised display of a selected physiological variable such as tongue position or the spectrographic waveform are excluded from this definition. Mobile applications are classified as mHealth and are also excluded. The Global Observatory of eHealth of the World Health Organization defines mHealth as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants and other wireless devices" (World Health Organization, 2011). Our aim was to solely review CBST programs that can be used in clinical settings as part of a treatment program for children with SSD.

Computer-based speech therapy programs have been shown to be beneficial in phonological awareness (Lonigan et al., 2003), reading (Nicolson, Fawcett, & Nicolson, 2000), child language (Schery & O'Connor, 1997), stuttering (Erickson et al., 2015) and aphasia management (Adrian, Gonzalez, & Buiza, 2003). For the treatment of SSD, CBST programs include comprehensive libraries of therapy exemplars, such as Sound Contrasts in Phonology (Williams, 2006) and Artic Pix (Cuda & Willard, 2004). Clinician-supported intervention programs, such as Phoneme Factory Sound Sorter (Wren & Roulstone, 2006) and Speech Sounds on Cue (Multimedia Speech Pathology, 2011) are also available.

Shriberg and colleagues (Shriberg et al., 1989; Shriberg, Kwiatkowski, & Snyder, 1990; Shriberg, Kwiatkowski, & Synder, 1986) evaluated the role of computers for the assessment and management of SSD (The Waisman Project Intervention Studies). They reproduced tabletop assessments and therapy materials on a computer screen to determine whether differences existed between tabletop and computer modes for effectiveness, engagement and efficiency. Tabletop and computer modes were equally effective, engaging and efficient (Shriberg et al., 1986; Shriberg et al., 1989; Shriberg et al., 1990). Anecdotal information from the supervising SLPs suggested that participants were more engaged with the computer mode. When given the option, 75% of participants in the response-evocation study (Shriberg et al., 1990) and 83% of participants in the stabilisation study (Shriberg et al., 1989) opted for computer-based therapy.

Supporting these findings, Nordness and Beukelman (2010) evaluated the effects of record-keeping on compliance with parent-led and computer-led home practice for children with SSD. The child's target words were presented as an audio-visual clip via Microsoft Office PowerPoint (Microsoft Corporation, 2013) for the child to imitate. Recording practice time increased the overall amount of practice and computer-led practice led to a further increase in practice time (Nordness & Beukelman, 2010). A survey showed that parents and children preferred the computer-led mode and were more inclined to practise in this mode.

For the Waisman Project Intervention Studies (Shriberg et al., 1989; Shriberg et al., 1990), techniques for evaluating effectiveness and engagement in each mode were subjective. Effectiveness (i.e. correctness of the child's response) was based on the feedback provided by the SLP in the therapy session with the child, not on the child's actual response and was measured after one (Shriberg et al., 1990) and two (Shriberg et al., 1989) therapy sessions. Neither study compared speech production pre and post intervention. Engagement was evaluated through observation of the SLP-child interaction which included observation of body posture, gaze and facial expression. The studies by Nordness and Beukelman (2010) and Shriberg et al. (1989, 1990) were limited by small sample sizes of eight (Nordness & Beukelman, 2010), 15 (Shriberg et al., 1990) and 18 participants (Shriberg et al., 1989). Nordness and Beukelman's (2010) single-subject withdrawal design with two interventions, included two computer-led treatment phases but only one parent-led treatment phase. The actual duration of each of the phases also varied across participants.