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An evaluation of speech production in two boys with neurodevelopmental disorders who received communication intervention with a speech-generating device

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ABSTRACT

Background: Children with neurodevelopmental disorders often present with little or no speech. Augmentative and alternative communication (AAC) aims to promote functional communication using non-speech modes, but it might also influence natural speech production.
Method: To investigate this possibility, we provided AAC intervention to two boys with neurodevelopmental disorders and severe communication impairment. Intervention focused on teaching the boys to use a tablet computer-based speech-generating device (SGD) to request preferred stimuli. During SGD intervention, both boys began to utter relevant single words. In an effort to induce more speech, and investigate the relation between SGD availability and natural speech production, the SGD was removed during some requesting opportunities.
Results: With intervention, both participants learned to use the SGD to request preferred stimuli. After learning to use the SGD, both participants began to respond more frequently with natural speech when the SGD was removed.
Conclusion: The results suggest that a rehabilitation program involving initial SGD intervention, followed by subsequent withdrawal of the SGD, might increase the frequency of natural speech production in some children with neurodevelopmental disorders. This effect could be an example of response generalization.

1. Introduction

Many children with neurodevelopmental disorders have limited natural speech production (Lang et al., 2010; Matson et al., 2012). These children are candidates for augmentative and alternative communication intervention (AAC). AAC intervention aims to provide the person with an effective non-speech mode of communication (Beukelman and Mirenda, 2013; Johnston et al., 2012). One increasingly popular AAC option involves the use of tablet computers that are configured with graphic icons and speech synthesizing software (McNaughton and Light, 2013; Sennott and Bowker, 2009). With this system, tapping icons on the tablet screen produces synthetic speech output. For example,

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tapping a *COLORING BOOK* icon might produce the message "*I would like the coloring book.*" The speech output provides a readily understood message, which is of benefit to listeners. In addition, synthetic speech output might also be of benefit to AAC users as discussed below (Drager and Reichle, 2010; Schlosser, 2003).

Several studies have demonstrated effective procedures for teaching children with neurodevelopmental disabilities to use tablet-based speech-generating devices (SGDs) for functional communication purposes (see Kagohara et al., 2013 for a review). Waddington et al. (2014), for example, taught three boys with autism spectrum disorder and severe communication impairment (expressive language ages of less than 2.5 years) to request access to preferred toys by selecting a sequence of icons from the screen of a tablet-based SGD. The boys were taught a sequence involving: (a) an initial general request (e.g., "*I would like a toy please.*"), (b) a second specific request (e.g., "*I would like the alphabet box.*"), and (c) a final "*thank-you*" response after receiving the requested toy. The teaching procedures involved least-to-most-prompting, time delay, error correction, and reinforcement. With intervention, all three children showed improvement in performing the communication sequence. This improvement was maintained with an unfamiliar communication partner and during the follow-up sessions. These results are consistent with Kagohara et al.'s (2013) conclusion that, with systematic instruction, children with neurodevelopmental disorders and severe communication impairment can be taught to use tablet-based SGDs for functional communication purposes.

While AAC intervention primarily aims to provide children with an augmentative or alternative means to communicate more effectively (Beukelman and Mirenda, 2013; Johnston et al., 2012), researchers have also been interested in whether such intervention might have some facilitative effect on natural speech production – a welcomed bonus to AAC intervention (Greenberg et al., 2013; Millar, 2009; Millar et al., 2006; Schlosser et al., 2009; Schlosser and Wendt, 2008). Blischak et al. (2003) proposed several hypotheses as to why the use of an SGD might enhance natural speech production, including (a) communication effects, (b) motor effects, and (c) acoustic effects. Communication effects might occur when increases in communicative turns, messages, and/or utterance lengths due to SGD use and intervention result in concomitant increases in speech production. Motor effects might stem from a reduction in physical demands (i.e., pointing to a symbol is seemingly less complex motorically compared to producing speech) and pressures to speak, which thus permit a re-allocation of cognitive resources toward the production of speech. Acoustic effects might result from the immediate acoustic output that provides activation feedback to the learner, an increase in the consistency as well as the quantity of the speech output models (which might result in better attention and imitation), and the pairing of graphic symbols with spoken symbolic output that might enhance the development of an internal phonology. In sum, there are plausible reasons why the use of an SGD might be expected to improve natural speech production. Alternatively, synthetic speech output from a SGD might conceivably inhibit natural speech production by preempting the need for speech and/or by creating an auditory distraction.

Several studies have investigated the effects of speech output devices on natural speech production in children with neurodevelopmental disorders (for reviews see Millar, 2009; Millar et al., 2006; Schlosser et al., 2009; Schlosser and Wendt, 2008). For example, Parsons and La Sorte (1993) reported an increase in spontaneous vocalizations when the six participating children with autism were using a speech-output device. In another relevant study, Schlosser et al. (2007) monitored the vocalizations of five children during intervention aimed at teaching the children to make SGD-based requests. In this study, the presence or absence of speech output from the device did not influence vocalizations for four of the five children, perhaps because these children evidenced very low levels of vocalizations and vocal imitation. For the other child, a minor and inconsistent facilitative effect was observed. Importantly, this child entered the study with some pre-existing vocal imitation skills. In a third relevant study, Sigafoos et al. (2003) also manipulated the presence and absence of speech output during sessions in which three children used a SGD to request preferred stimuli. Two children had autism and one had Leber's Congenital Amaurosis and intellectual disability. They found that speech output from the SGD did not inhibit vocalizations in the two children with autism. Interestingly, the child with Leber's began to speak relevant single words (e.g., *biscuit*, *juice*) during the latter sessions regardless of whether or not the speech output function of the SGD was on or off.

The varied findings across these studies might stem from differences in the participants' preexisting vocal/speech skills and from the fact that vocalizations were defined and recorded in different ways across the three studies as noted by Schlosser et al. (2009). Still, the data from existing studies suggest that SGD-based speech output does not inhibit vocalizations/natural speech production and in some cases SGD-based intervention might even facilitate natural speech (Millar, 2009; Schlosser et al., 2009). However, given the relatively few number of studies to date, additional research would seem warranted.

The present study was designed to extend the existing literature in three new directions. The first and primary aim was to provide additional data on the effects of a systematic instructional protocol for teaching children with neurodevelopmental disorders to use a tablet-based SGD for functional communication purposes. An additional demonstration of this type would help to extend the generality of this approach to AAC intervention, which is critical to advancing knowledge regarding intervention effectiveness (Dallery et al., 2013). The second aim was to investigate the effects on natural speech production of teaching two children with neurodevelopmental disorders to use a new generation of tablet computer (i.e., an iPad®) as a SGD. With the proper software, an iPad® can function as a SGD and produce relatively high quality synthetic speech output, which we hypothesized might serve as an effective speech model for the children to imitate. The third direction pursued in this study arose fortuitously when we noticed that the two boys started speaking single words during the initial intervention phase when they were being taught to use the SGD to request access to preferred stimuli. In light of this, we redesigned the study to determine if we might be able to evoke more frequent speech production by removing the SGD, while endeavoring to maintain the need/motivation for communication. The idea is based on the phenomenon of response generalization (Skinner, 1953), whereby reinforcement of one requesting response (e.g., using the SGD to request preferred objects), might increase other requesting responses (e.g., using single words to request those same preferred objects). Thus, in the present study, we predicted that natural speech production would increase by first teaching the alternative (SGD-based) response and then preventing that response by simply removing the SGD, while maintaining the motivation/need to communicate.

2. Method

2.1. Ethical clearance and informed consent

Ethical approval was obtained from the relevant University committee and parents provided informed consent. The children were minors and did not have sufficient receptive and expressive language skills to give informed consent. However, their assent was inferred from their willingness to participate in the sessions and eagerly playing with the preferred stimuli that they were being taught to request.

2.2. Participants

Two boys attending a university-based clinic were recruited for this study because they had neurodevelopmental disorders and severe communication impairment. IQ scores were not available, but an adaptive behavior assessment was