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Does a Computer-Assisted language training program improve social conversational skills in Autism spectrum disorder?

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Abstract

Study Purpose: The primary hypothesis of this study is that a computer-assisted program that provides immediate feedback about matching critical acoustical features in speech may help to shape effective conversational skills in individuals with autism spectrum disorder (ASD).

Background: Studies in psycholinguistics have demonstrated the importance of vocal congruence or "matching" in conversational speech. In typical dyadic conversation those individuals who match critical acoustical patterns, including pitch, rhythm and volume, of their conversational partners are generally viewed as more socially effective. Individuals with ASD do not match these patterns as effectively as neurotypical individuals (NT).

Presentation of hypothesis: Pilot studies utilizing an Ipad-based software program that provides visual feedback of percentage match of pitch, rhythm, and volume is presented that suggests that such strategies may improve social conversational skills.

Testing Methods: Open trials of 10 daily training sessions with cohorts of adults and adolescents with diagnosed ASD showed improved matching abilities and generalizability to real life conversations. Larger numbers of subjects should be studied utilizing web-based access to the software along with cloud-based data analytics to assess efficacy.

Implications of the hypothesis: Computer-based feedback strategies may be useful for shaping pragmatic language skills in individuals with ASD. If found to be effective access to speech and language training could be extended beyond the current limitations related to access to face-to-face speech therapy.

Keywords: Autism, software, speech

Introduction

In the Neurolab we have focused on the unusual conversational styles of children and adults with ASD. These individuals have a quirky approach to dyadic speech in which they tend to ignore emotional content and tend to speak "at you" rather than "with you." Previous studies in psycholinguistics have documented the importance of vocal congruence or matching which occurs in typical conversation [1,2]. This research showed that non-autistic individuals tended to match non-content aspects of speech (e.g., volume, pacing) when speaking with another person. More recent research shows that individuals with ASD tend not to match critical parameters of speech when speak-ing to a non-autistic person [3,4]. Diehl and his colleagues [3] found higher variability in pitch in individuals with autism when expressing emphatic stress as well as longer duration of pauses, a sign that pacing of speech differed in this group. Shriberg and colleagues [5] have pointed out that problems in prosody may constitute the greatest roadblock to social and vocational success. Their study comparing speech characteristics of ASD and non-ASD subjects suggest some differences in pitch and resonance quality. Later additional analyses of the same study data confirmed problems in intensity, pitch and duration of utterances which were linked to social difficulties [6].

Since individuals with ASD respond well to visual stimuli

[7] it may be that providing feedback in the form of sound wave images and percentage match of volume, rhythm and pitch may be useful in shaping more effective conversational speech. An operant model [8] suggests that reinforcement by successive approximations to a goal behavior is effective in producing new language behaviors.

Pilot studies in our own lab [4,9,10] showed that training utilizing a software program called Speechmatch results in improved matching abilities. For example a sample of 5 adults who received 10 days of 2-hour training sessions demonstrated improved matching of critical parameters of speech as well as generalizability to simulated "free conversations" with a research assistant. **Figure 1** shows improvement in matching across the 10 training sessions.
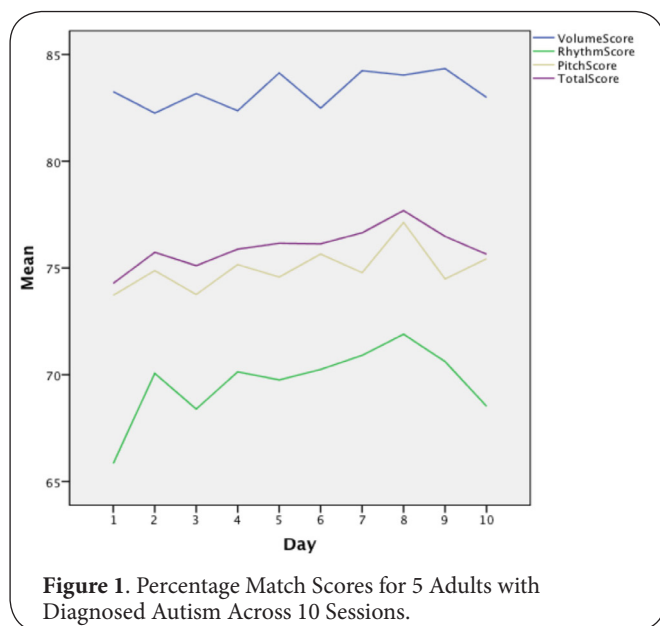

Figure 1. Percentage Match Scores for 5 Adults with Diagnosed Autism Across 10 Sessions.

This pilot study involved 5 males ages 18-24 with each session consisting of practice for 5 phrases (happy, sad, unpleasant surprise, pleasant surprise and neutral) for 20 minutes per phrase. The study received approval from the College Institutional Review Board. While these first to last session improvements were of small but significant magnitude, it may be that small changes serve as "tipping points" for improved social connection.

Presentation of hypothesis

Reflecting a concern that children with autism fall out of sequence in developing social skills, a hypothesis emerged that this problem could be corrected by means of intensive vocal matching training using a simple software solution. A collaboration with a music software developer, Robert Taub, resulted in creation of an iPad-based platform prototype that contains pre-recorded phrases containing various emotional content (happy, sad, pleasant surprise, unpleasant surprise, neutral statements). The subject first hears the phrase and simultaneously sees the sound wave generated by the pre-recorded phrase. The subject then speaks the phrase, attempting to match the sound wave on the screen. The subject then sees his/her own sound wave as well as percentage match numbers for volume, rhythm, and pitch. With practice the goal is to improve match scores across time. **Figure 2** illustrates the tablet screen following repeating of a phrase.
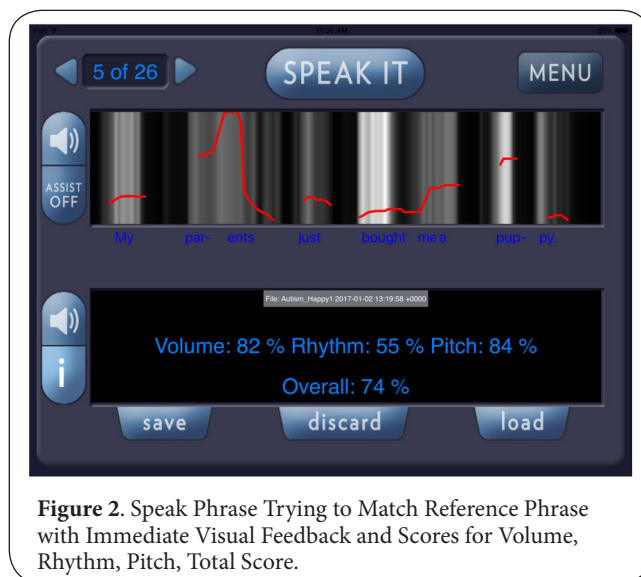

Figure 2. Speak Phrase Trying to Match Reference Phrase with Immediate Visual Feedback and Scores for Volume, Rhythm, Pitch, Total Score.

The visual representation of the sound wave depicts three parameters of speech that are critical for shaping speech in social conversation, namely volume (amplitude of the sound wave), pacing (rhythm), and emotional content (pitch). Rhythm and volume are represented on the x-axis whereby the spacing of the wave image represents pacing and the gray and white vertical bars represent volume (the whiter the bar the greater the volume). Pitch is represented by the positioning of the sound wave image on the y-axis. Visual feedback of both the subject's sound wave and their percentage match scores are immediate.

The idea that conversational language skills can be improved by means of active visual feedback is surprisingly a neglected area of inquiry. This hypothesis suggests that the biochemical [11] and neural differences [12] inherent in autism may not fully determine the limits of improvement in social skills. A different view that argues that behavioral training may create opportunities for neuroplastic change should be considered. If future studies based on larger subject samples and more controlled research establishes not only improvements in acoustical matching but also transfer of training to real life social situations then a new paradigm may emerge that provides possibilities for enhanced social functioning and success for people with ASD.

Testing the hypothesis

A quick search for "Autism Apps" on phone or tablet reveals hundreds of options with few that have been empirically investigated. While all of these online tools hold out hope for parents and professionals it is of the highest importance that hypotheses related to efficacy of software programs be carefully evaluated. In terms of validating the Speechmatch software, preliminary study alone has involved several years of examining different levels of training (e.g., 20 minutes vs. 2-hour training periods) which are akin to "dosage" studies in pharmacology and "open trials" (non-controlled studies) with different ASD age groups (e.g., young children, adolescents, adults). While larger controlled studies involving different diagnostic groups await further research funding, a more realistic approach will involve use of cloud-based data analytics which permit large-scale data collection on volunteers who download and use the program. A clarion call to other research groups to study the efficacy of language training software programs such as Speechmatch is part of our work.

Implications of the hypothesis

Professionals in the autism field have struggled to find efficient and effective ways to improve social conversational skills in individuals with ASD. Current professional approaches, while somewhat helpful, are time and labor intensive requiring many face-to-face hours with speech and language therapists, occupational therapists, school guidance counselors, and psychologists. If the hypothesis that a computer-assisted software program that is easy to implement at home or school, which provides visual feedback about acoustical matching of volume, rhythm and pitch can improve conversational skills, then people with ASD may be well served. There are many tools now available for people with ASD and it is imperative that professionals have the option to select those which have been empirically studied and validated.

List of abbreviations

ASD: Autism Spectrum Disorder

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