Dissemination article

Abnormal speech prosody has been widely reported in individuals with autism. The research on prosody production among individuals with ASD is important because speech prosody is a key component in communication. It is known that prosodic impairments and social communication are strongly correlated and impairments in speech prosody can negatively affect friends making and job seeking. Multilingual exposure is increasing among children with autism spectrum disorder, but the acquisition of speech prosody by this population in both native and non-native tone languages has rarely been examined. This study acoustically evaluated the use of Cantonese and Mandarin speech prosody to mark information structure by children with and without autism spectrum disorder. Our results showed insufficient use of prosodic cues in by children with autism spectrum disorder in both Cantonese and Mandarin. However, the difficulties autistic children faced in the acquisition of speech prosody in a non-native tone language are not larger than those they face in their mother tongue.

In addition, we designed sung-speech training programs as shown in Figure 1 and positive training effects have been found in the use of prosodic cues in both Cantonese and Mandarin. Using similar acoustic cues in music and speech, the sung speech is designed in a way to boost the acoustic cues such as f0, duration and intensity in on-focus words reflected in the melody line and rhythmic pattern, which reinforces the acoustic cues generally used in speech and in turn may have improved their mapping of prosodic cues to information

structure and help them to transfer what they have learned through the music to speech production.

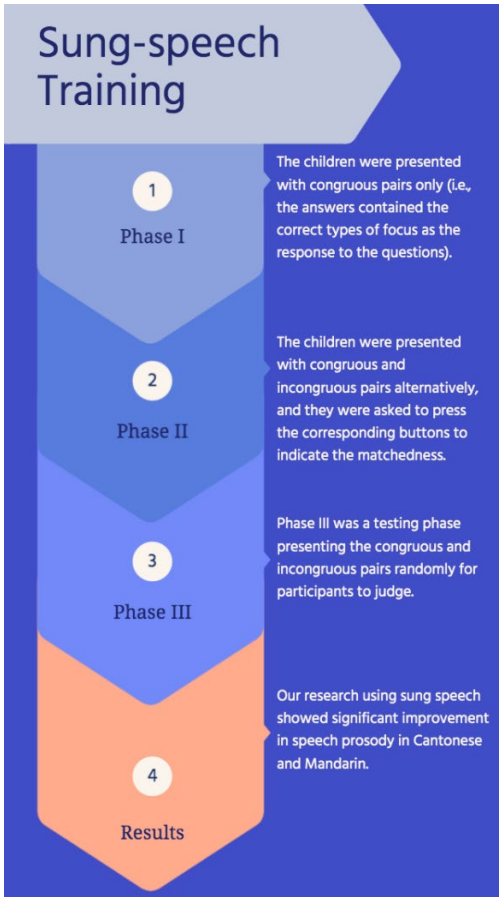

Fig 1. Three phases of sung-speech training

A social robot has now been programmed to be able to implement the sung-speech training program we have designed. The training materials and publications will be available in our website https://sichen-lab.com/.

Our research has important implications for supporting communication development in autistic children. Difficulties in using prosodic cues can significantly impact an autistic child's ability to effectively convey communicative intents, which can create barriers in social

interaction and have far-reaching impact.

Speech therapists working with autistic children could consider incorporating sung-speech exercises and activities into their treatment plans. Providing autistic children with ample exposure and practice with the prosodic features of language in a musical context may facilitate their ability to apply these skills in natural, conversational settings. The therapists are also welcome to use our training materials available using E-prime or a virtual robot to train autistic children to improve their use of speech prosody.

For parents of autistic children, our findings suggest that engaging their child in musical activities, such as singing, may have beneficial effects on their child's communicative development. By making prosodic patterns salient through sung-speech, parents can help build their autistic child's awareness and internalization of this crucial component of language. Moreover, we also found that exposure to a third language does not seem to put extra burden on autistic children, and they learned more about how to use prosodic cues in their third language. Speech therapists and parents may thus also keep in mind that multilingual exposure may bring some benefits in learning prosodic cues.