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Case Report

Assessment of a Vocal Training Experiment in ASD Child

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Abstract

In Autism Spectrum Disorder (ASD), children's language profiles are heterogeneous, ranging from a total absence of vocal gestures to a preserved structural language with abnormal intonation, rhythm, or speech rate. Studies on vocal production in ASD have revealed an important intervariability in these individuals but no acoustic feature can be, currently, considered as a marker of ASD. In this context, we hypothesize that the voice in some ASD individuals could be educated. We have developed a vocal training protocol, based on the "Belcanto model technique". This protocol proposes to an ASD child to reproduce exactly as precisely as possible some vocal gestures from a living trained model (the experimenter) on a several week period.

The practice of gestures not only trains breath, sound, and intonation (BSI), and also breathes sound and pronunciation production (BSP). Such a practice mobilizes both the imitation and the joint attention. The preliminary results of the training of an 8-year-old child with ASD reveal first a good adaptation of the child to the task (mobilization of joint attention and imitation). Then, the child improved the duration vocalic production, reproduced the melodic envelope from the model and diversified these intonation patterns.

ABBREVIATIONS

BSI: Breath Sound Intonation; BSP: Breath Sound Pronunciation

INTRODUCTION

Autism Spectrum Disorder (ASD) (DSM, 5) is characterized by persistent deficits in communication and in social interactions, by stereotyped behaviors and restricted interests. In ASD individuals, children's language profiles are heterogeneous, ranging from a total absence of vocal gestures to a preserved structural language with abnormal intonation, rhythm, or speech rate. These speech abnormalities have an impact on pragmatic communication.

Since the 1980s, studies on prosody in ASD individuals reveal acoustic abnormalities [1]. Similarly, screams, grunts and howls have been observed, particularly in children with low verbal and with intellectual deficit. Other studies reveal significant variations in fundamental frequency [2]. Since 2003, improved technical tools have led to further studies on speech production in ASD [3], which reveal prosody abnormalities.

Prosody could play an important role in the socio-communicative deficits (pragmatic deficit) [4]. The research focuses on different acoustic aspects of the voice such as: fundamental frequency (F0), volume, duration and voice quality [5]. The fundamental frequency is defined as the frequency of vibration of the vocal cords during a production. Individuals modulate their F0 to convey a pragmatic or contextual meaning (imperative sentence, ironic intention, expression of emotions) [6-10]. This variability of F0 found in ASD individuals has an impact on the verbal production thus conveying bad pragmatic information (communicative intention).

However, a literature review [10] reveals that out of 16 studies comparing ASD vs neurotypical individuals, only 2 studies found out significant differences between ASD and control individuals with a higher F0 average [11,12]. 14 studies found no significant difference between people with autism and control subjects. These results attest to an important intervariability of the fundamental frequency but that, in no case, is a marker linked to autism. Other studies focus on the speech volume described as too strong or too low [13].

Moreover, Martel indicates that children with autism have significant difficulties with the prosodic module [14]. These disorders of the expressive prosody generate a communicative deficit for these children. Regarding to voice and song [15] show that autistic teenagers have a reduced vocal range. Explain that prosody could be deviant in the autistic children babbling [13]. However, these deficits could constitute a handicap to develop the language. But [16] - and according to [17] - indicate a potential: «In dissociation between singing and speech, some children diagnosed with autism that are essentially non-verbal and do not speak, can sing familiar songs». Indeed, according to [18], neurotypic infants are sensitive to intonation, to prosody. Boysson-Bardies even presents prosody as the basic element of the babies' entrance into language [19]. It would be perceptual "glue" for speech sequences because it organizes the temporality,

the rhythm and the linguistic unit segmentation.

Finally, prosody and intonation are components that stimulate joint attention, which is a fundamental condition in the process of language appropriation [20-22].

These different studies lead us to believe that there would be no prosodic markers specific to autism but different ways of using prosodic elements. From the total absence of their use (flat prosody) to an inappropriate use for communicative context (pragmatic deficit).

We hypothesize that weekly vocal training could change some acoustic cues in ASD children who present important intonative abnormalities. The training aims to modify the acoustic production of the ASD child and to tend towards a production closer to the adult model. This qualitative study is only a pilot study on a phonetic assessment of acoustic cues.

CLINICAL CASE PRESENTATION

Parental concerns

In 2017, parents came to the Autism Resources Center in Marseille (France) and reported communication and social interaction difficulties of their 8 year old son. This boy was born full-term by normal vaginal birth with no prenatal, perinatal and postnatal complications (weight: 3.73 kg, length: 52 cm). He had lactose intolerance in early childhood. First parental concerns were about an isolation of their son from his peers, some restricted interests (puzzle) and some behavior disorders.

Preliminary hypotheses about a possible autism spectrum disorder were brought up by different specialists but have never been established. During early childhood, hearing control showed no hearing loss, nap EEG was normal, and genetic testing revealed no abnormalities.

Currently, parents reported some difficulties in reciprocal social interactions (unusual eye contact, social openness lack of quality), some difficulties in conversation and speech important abnormalities (atypical intonation).

Assessment

According to the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders [13], the child was diagnosed with Autism Spectrum Disorder. The diagnosis was made by the psychiatrist and the multidisciplinary team of the Autism Resource Center and is based on results from different tests and diagnostic scales.

This boy scored in the range of impairment on all three Autism Diagnostic Interview-Revised (ADI- R) [24] subsections (reciprocal Social Interaction = 20 > 10; Language and communication = 16 > 8; Restricted, Repetitive and Stereotyped Behavior = 3 ≥ 3).

The child was also assessed with the Autism Diagnostic Observation Schedule (Second Edition) (ADOS-2) [25]. The Module 3 was administrated because the child had "fluent" language skills, estimated over a 4-year-old level in production and in reception (VAB's communication standard score: 89).

In the ADOS-2 algorithm, a score of 13 (Social Affect = 10; Restricted and Repetitive Behavior = 3) suggested a diagnosis of ASD. During the assessment with the ADOS 2 (Module 3), the item "Speech abnormalities associated with autism (intonation, volume, rhythm, and rate)" received a rating of 2, showing clearly inappropriate prosody, volume and rhythm in this child.

Otherwise, this child presented no intellectual deficit (IQ = 118 on WISC, 5th Edition).

No cerebral imagery or naps EEG were requested. Genetic tests revealed a normal karyotype and the results of the array comparative genomic hybridization (CGH-array) showed no abnormality.

"Vocal training" procedure

In association with the Resources Autism Center, the Language Observation Center (COLOE) developed a protocol in "vocal training program". The "Belcanto technique" has helped us to conceptualize two differentiated practices: on the one hand the productions of sung sounds, and on the other hand, the production of spoken sounds. We strove to be as close as possible to the coordination of the different necessary physical activities. The breathing is transformed into a held breath, the vibration is transformed into sound and the mastication is transformed into syllabic vocal gestures. We have thus developed two specifics modules: the Breath Sound Intonation (BSI) and the Breath Sound Pronunciation (BSP) (SSI and SSP in French)[1] [26].

This procedure was proposed to this child and his family during 2 months. The child received one and half an hour of vocal training per week (three half-an-hour sessions). The experimenter was specifically trained in BSI / BSP in order to conscientiously transmit the appropriate vocal gestures to the child and supervise the training at home. The trained experimenter showed some breathing gestures, some laryngeal gestures and some articulated sounds. The child had to imitate identically the "adult vocal model".

The first aim is to identify the child's ability to repeat in the same way, focusing his joint attention and imitation skills. The second aim is to assess if the training impacts some acoustic characteristics (vowel duration, stability of musical notes and intonation patterns) in this child. The used software is Praat.

PROCEDURE RESULTS

First, the results reveal the child's skill to focus his attention on the adult and to mobilize his imitation skills during the training.

These results reveal first that the child presents skills in prosodic imitation. During the first assessment, the child can reproduce three music notes as the "adult vocal model" but not the last two. The child has not enough energy to hold the last two notes.

The last result shows that before the training, the child could only reproduce the words, but not the prosody at the same time. The succession of breath groups (on the right Figure 4) prevents the setting up of the legato (continuous intonation).

[1] In French, SSI means Souffle Son Intonation, SSP means Souffle Son Prononciation

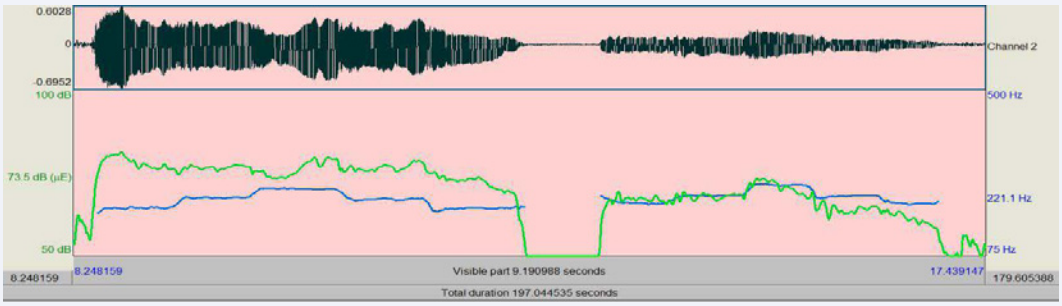

Figure 1 Five music notes (CDEDC) before training Adult model (on the left) followed by the child production (on the right).The green line is the energy (dB) and the blue line is the prosody (Hz).

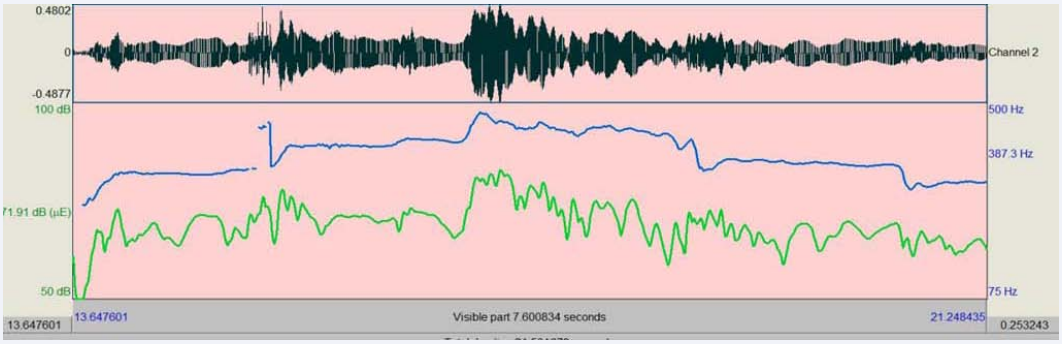

Figure 2 After training only the child production

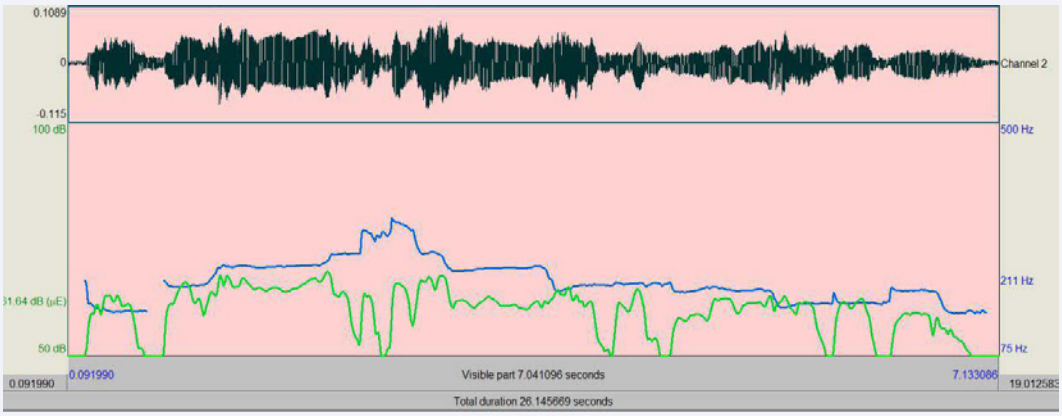

Figure 3 The french song "la fourmi m'a piqué la main" ("The ant stung my hand") Adult model.

After the training, he can reproduce the song with a better coordination between sentences and prosody. These results also reveal that the child has to train to adjust the speech sounds and the prosody pattern (Figure 4,5). This coordination is not spontaneous and requires an education.

DISCUSSION

First, vocal training could constitute an interesting material to focus joint attention and imitation skills in some autistic individuals. This preliminary study results are strictly qualitative and confirm that a child with autism can focus joint attention on the prosodic elements but it requires a regularly and specific training. It appears that an ASD child cannot appropriate these acoustic elements in ordinary speech practices like young neurotypical children do.

Then, the vocal range, which is sometimes reduced in some autistic children or teenagers [15] could be trained or educated and confirm that the F0 is not a marker linked to autism. As we have seen in litterature, this child's fundamental frequency is not autism's deficit and it's possible to train it. This first result is particulary interresting for the staff working with ASD child.

Secondly, the differences between speech sounds and prosody (music sounds) reveal the difficulties of coordination of speech sounds and music sounds in some ASD children. This

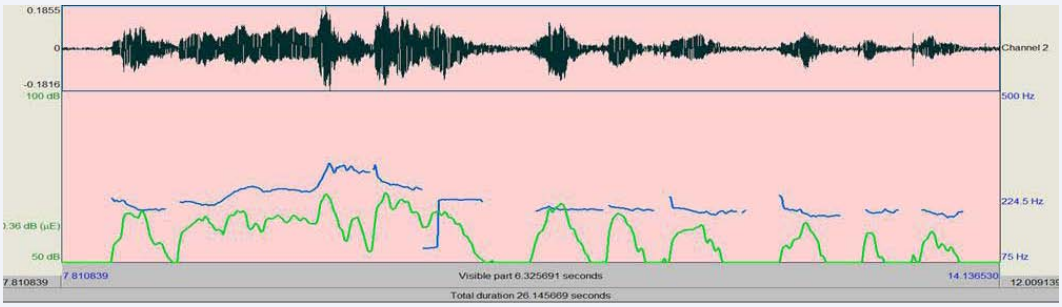

Figure 4 The child's production before training.

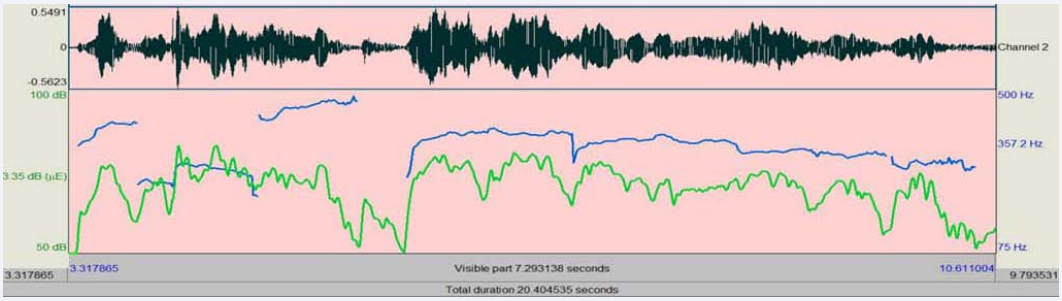

Figure 5 The child's production after training.

Table 1: Vocalic durations before and after training

Vocalic sounds	Before training	After 8 weeks training
/a/	5 sec	16 sec
/i/	6 sec	18 sec
/o/	4 sec	14 sec
/e/	4 sec	10 sec
/u/	3 sec	13 sec

coordination could be the first step in pragmatic activities and should be trained specifically for ASD children.

The results of our study justify the necessity to separately educate BSI and BSP modules. Prosody training should start without phonemes' pronunciation then with addition of phonemes' pronunciation supported by the melody. As the notes carried out by the melody are acoustic invariants unlike phonemes, the fact that a training of melody (and prosody) is possible is potentially an element of stablisation to enter language practices.

We hypothesize that some ASD children have difficulties to appropriate prosodic elements during their language development, because of deficits in joint attention or social interactions or because of sensorial particularities.

Unlike neurotypical children [19], the ASD children would not use or they would wrongly use the natural speech prosodic elements to "co-construct" temporality, rhythm or linguistic unit segmentation.

This hypothesis leads us to consider the need for a vocal training program for some ASD children like a vocal education in two separate modules: BSI and BSP.

This study continues with the above mentioned boy in order to observe if prosodic changes appear in his spontaneous speech.

Our qualitative approach is a limit. Nevertheless, in the case of ASD children, the profiles' heterogeneity does not allow a conventional statistical treatment to assess such training. Next study will integrate 4 children and will be evaluated with single-case experimental designs, SCED [27]. A new vocal training program based on "Belcanto model technique" is soon beginning with four other young ASD children [28,29].

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