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Points of view: positive effects of the Beataalk technique on speech characteristics of young adults with intellectual disability

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Background: The Beataalk technique is a speech therapy method, based on human beatboxing, involving intense, rapid repetitions of speech-like sounds. The goals of the current feasibility study were to test its effect in enhancing articulation accuracy and voice measures in a small group of adults with intellectual disability (ID), using a wide range of measures of verbal communication, and to refine the treatment protocol.

Methods: A group pre-test–post-test experimental design was used ($n = 12$). Treatment consisted of ten weekly group sessions of 40 min, each followed by two self-practice sessions. Changes in speech intelligibility, voice, and communication skills were assessed.

Results: The findings indicate significant improvements in speech production and intelligibility measures (Percentage of Consonant Correct, and staff-member intelligibility scores), voice measures (vocal loudness, Harmonic-Noise-Ratio, shimmer, and jitter) and staff-member communication scores.

Implications: These results extend our understanding of the effects of the Beataalk technique, and suggest that it may have potential as an effective intervention for adults with ID. As the experimental design is limited in its ability to yield strong conclusions, further controlled studies are required.

Keywords: intellectual disability, speech impairments, speech intelligibility, human beatboxing, Beataalk

Many children and adults with mild to moderate intellectual disability (ID) demonstrate speech impairments and reduced intelligibility (Cheslock *et al.* 2008; Terband *et al.* 2018). Such speech impairments adversely affect the personal well-being of individuals with ID (Coppens-Hofman *et al.* 2016), may reduce social skills and participation, and lead to behavioral problems and isolation (Bott *et al.* 2007). Hence, promoting verbal communication abilities is an important therapeutic goal in rehabilitation programs of individuals with ID over the lifespan, as individuals with mild to moderate ID primarily use verbal means of communication (Roberts *et al.* 2007).

The inclusion of musical-interaction activities (e.g. choir singing) within speech treatment for adults may improve communicative outcomes, as such activities were found to have both personal as well as social positive impact for adults living with a chronic mental illness or disability (Dingle *et al.* 2013). Musical interactions and music therapy were also found to enhance communicative skills in individuals with ID (Wigram *et al.* 2002). In a recent review, Johnels *et al.*

(2021) evaluated research on musical interaction and music therapy in children and young people with severe or profound intellectual and multiple disabilities, and described the positive effect of such activities on various developmental abilities (such as social and communicative skills; Wheeler and Stultz 2008). Several musical interaction approaches were identified, of which the most commonly applied was active music therapy. Importantly, some components of musical interaction were acknowledged as promising, among which are the responsivity of the interaction partner, singing songs, structure and predictability in the activities, long-term interventions, technology-mediated and multisensory musical activities, and a therapeutic alliance between interaction partners.

Joining these findings, we wish to describe a novel, musically-based speech therapy method, the *Beataalk* technique, which uses human beatboxing practice to enhance measures of verbal communication, and may be suitable for individuals with ID. This technique originates from the *a cappella* art of human beatboxing, which involves producing vocal percussions and non-verbal sounds in a way that imitates musical instruments, using the entire vocal tract (de Torcy *et al.*

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Table 1. The current study – description, design, and results.

Participant characteristics (n, age, gender)	12 adults with mild to moderate ID and challenging behavior (age range: 22–53 years; mean age: 36 years; ten females).
Study design/ Data collection methods	A pre-test–post-test design, group intervention. 12 consecutive weekly sessions: one pre-intervention session, ten intervention sessions, and one post-intervention session. Quantitative data was collected. Analyses were conducted following the completion of the data collection by two trained research assistants (speech-language pathology students), blinded for the participant condition (pre- or post-intervention).
Musical interaction activities	Active music therapy, group setting. The following sounds were chosen for acquisition and rehearsal (practice): the <i>kick drum</i> [p], the <i>hi-hat closed</i> [t] and <i>open</i> [ts], the <i>snare drum</i> [k], and the <i>snare meshed</i> [kS]. The practice rhythms varied in complexity level. Each weekly session lasted 40 min; 15 min of repetition of the sounds and rhythms of the previous sessions, each participant separately, and then all together in a ‘band’, 15 min of learning and practicing new sounds and rhythms (separately and together), and 10 min of group practicing performing musical accompaniment to a familiar song of their choice. The intervention sessions were delivered by a different pair of research assistants (speech-language pathology students).
Abilities and behaviours in focus	Speech production assessments were conducted, in which voice recordings were obtained (sustained phonation, single words, continuous/ spontaneous speech) to assess speech production and intelligibility and voice characteristics. Speech intelligibility and communication questionnaires were completed by the daycare staff members.
Reported benefits/ effectiveness, promising components	Statistical analyses (a set of paired samples <i>t</i> -tests, single tailed, for each of the tested measures) revealed the following seven variables to be significantly different from pre- to post treatment: Percentage of Consonant Correct (%), staff-member intelligibility score, Harmonic-Noise Ratio (dB), shimmer (%) and jitter (%) of sustained phonation, loudness (dB) of continuous speech, and staff-member communication score. Marginally significant difference was found from pre- to post treatment in Proportion of Whole-Word Correctness (%).

2014; Saphavee *et al.* 2014). Learning to beatbox is relatively simple, achieved mainly through imitation (Sharon and Bell 2012). Practicing beatboxing is commonly considered fun and enjoyable, and many teenagers and young adults feel that beatboxing is socially acceptable and personally rewarding (Thompson 2011).

Along with these benefits, other features make it particularly suitable as a therapeutic tool in speech therapy (de Torcy *et al.* 2014). First, many beatboxing sounds are consonant-like sounds, the most common of which are ejectives and nonstandard fricatives. For example, the *hi-hat* sound mimics the articulation of the voiceless alveolar plosive [t] or the affricative [ts]. Second, beatboxing relies on intense laryngeal, oral, and vocal activity (de Torcy *et al.* 2014; Saphavee *et al.* 2014), and requires control of the oropharyngeal and oral structures. The use of the pharyngeal constrictors creates a longer closed phase of the vocal folds, thus increasing subglottal pressure (Buescher and Sims 2011) positively affecting vocal loudness and quality. Similarly, the involvement of the hypopharyngeal cavity (as a resonator) enhances harmonic resonance (de Torcy *et al.* 2014; Honda *et al.* 2008). Third, as a type of musical vocal art (like singing; Krauss and Galloway 1982), beatboxing may promote various speech-related skills, such as respiratory capacities (to prompt a louder voice;

Decker and Kirk 1988), posture, speech rate control, and intelligibility (Cohen 1994; Clift and Hancox 2001). Taken together, these characteristics of human beatboxing have led us to consider it as a therapeutic tool in speech therapy, establishing the BeataTalk technique (Icht 2019).

This technique involves the learning of basic beatbox sounds and producing these sounds repeatedly in various rhythms and combinations, from simple (e.g. repeating a certain single sound - [p p p]) to complex (e.g. repeatedly producing a pair of sounds - [p-ts p-ts] or [k-kS k-kS], or a sequence of three sounds - [p-p-ts p-p-ts] or [k-k-kS k-k-kS]). Ultimately, such practice is intended to improve articulation accuracy, speech intelligibility, and voice production.

In a preliminary study, Icht (2019) introduced this technique and evaluated its efficiency in improving speech production measures (articulation accuracy and voice) in a small group of adults with moderate ID and low speech intelligibility. The participants were assigned to a BeataTalk (study) group ($n = 6$) or to a traditional therapy group ($n = 6$). Intervention was delivered by a team of experts (a beatbox artist and an experienced Speech-Language Pathologist, SLP, accompanied by the SLP of the day-care center). The program lasted six weeks, and verbal abilities were assessed pre- and

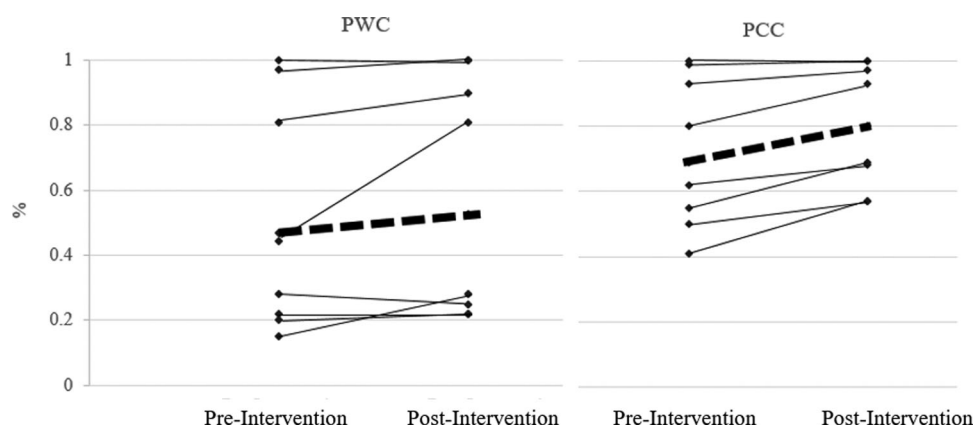


Figure 1. A visual illustration of the pre- to post-intervention Proportion of whole-word correctness (PWC) and percentage of consonant correct (PCC) scores (individual as well as group level data). The thin lines represent individual participant; the thick dashed lines represent group means.

post-intervention. The results demonstrated that both types of therapy yielded improvements in articulation accuracy and voice measures, with larger gains for the Beataalk technique.

Given the supportive nature of these initial research findings, here we present further evidence of the effectiveness of the Beataalk technique. We assessed various dimensions of the therapeutic effect and developed the treatment protocol. Thus, the current intervention group was larger ($n = 12$), intervention duration was longer (10 weeks), and therapy sessions were delivered by SLP undergraduate students. The description of the study, its design and results are presented in Table 1, in a similar fashion as in Johnels *et al.* (2021).

As detailed in Table 1, the current data showed positive changes in measures of speech production and intelligibility, voice, and communication. For example, intelligibility was measured at two speech levels: single words and continuous speech, using the following measures: (a) The Proportion of Whole-Word Correctness (PWC, %; Ingram 2002) – assessing what proportion of the individual's words were produced correctly out of the entire produced vocabulary; (b) Percentage of Consonant Correct (PCC, %; Shriberg and Kwiatkowski 1982) – the percentage of correct consonants in a given sample; (c) SLPs' intelligibility score – Five experienced SLPs, blinded to the study goals and participant status (pre- or post-intervention) listened to the recordings of the continuous speech and were asked to rate speech intelligibility on a five-point scale (The NTID rating scale; Schiavetti 1992), from 0 (indicating that the speech sample was completely unintelligible) to 4 (indicating that the sample was completely intelligible); and (d) Staff-member intelligibility score – Three staff members of the daycare center (two teachers and a volunteer) were given a short intelligibility questionnaire (adapted from: Kumin 1994; for example, 'How well can you understand the participant when he uses a single word?'), to be scored on a six-

point scale (from 0 = never, to 5 = extraordinarily well). Following the intervention, a significant improvement was documented in the PCC (from 0.69 to 0.8) along a marginally significant improvement in the PWC (from 0.5 to 0.58; see Figure 1). Given the fact that the Beataalk technique involves repetitions of consonant-like sounds (rather than words), these results were not surprising. It is possible that the practice of a specific target beatbox sound (e.g. the *hi-hat*) during intervention, positively affected the participants' ability to produce its analogous speech sound ([ts]) in the context of words. That is, following the intervention, participants attempted to generalize the production of the beatbox sounds when producing words, improving word articulation using the Beataalk principles.

Assessing speech intelligibility in continuous speech, we compared the pre-treatment staff-member intelligibility scores to the post-treatment scores (raw scores were converted to proportions). This analysis revealed a significant improvement, from 0.41 to 0.51 (improvement in this measure was documented for seven participants). We suggest that the improvement in consonant accuracy (PCC) leads to an improvement in staff-member intelligibility ratings, that can be taken as an indirect measure of a client's intelligibility.

Note, the SLPs' intelligibility scores did not differ from pre- to post-intervention. Clearly, intelligibility is rooted in characteristics of a speaker-listener dyad and the communication conditions, and depends on many variables, for example, listener familiarity (Liss *et al.* 2002) and nature of the linguistic message (Kent *et al.* 1994). The fact that the staff members knew the participants, and scored intelligibility based on daily communication, yielded a more subjective measure, possibly open-to-bias. This may explain their relatively higher post-intervention scores. In contrast, the SLPs' intelligibility scores were based on a blind analysis of a single specific speech sample (recordings of the picture description task), with no prior acquaintance with the

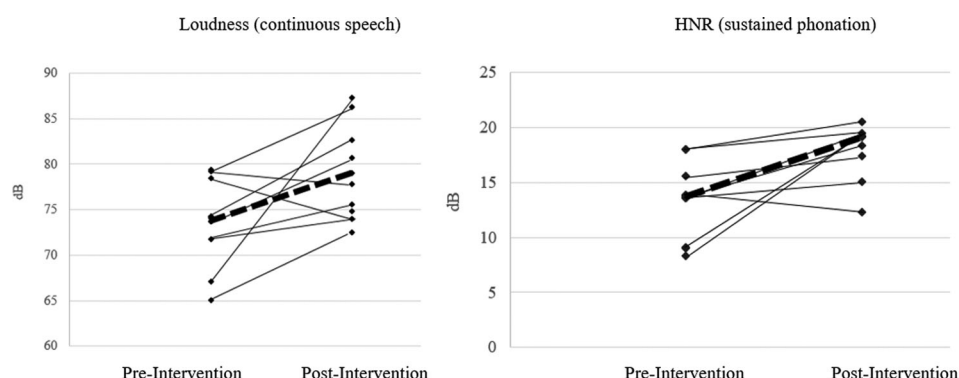


Figure 2. A visual illustration of the pre- to post-intervention loudness (for continuous speech) and HNR (for sustained phonation) values (individual as well as group level data). The thin lines represent individual participant; the thick dashed lines represent group means.

participants, resulting in a more objective and rigorous index. The discrepancy between these findings necessitates further research to examine the effect of the intervention on speech intelligibility in the wider context of continuous speech.

Analyzing vocal changes following the intervention in sustained phonation revealed that post-treatment, participants showed a significant increase in Harmonic-Noise Ratio (HNR, the ratio of the acoustic energy of the harmonic components to that of the noise, dB), from 14 to 18 dB (see Figure 2). The HNR relates to voice quality; a high HNR is associated with sonorant and harmonic voice, while a low HNR indicates an asthenic voice and dysphonia (Teixeira *et al.* 2013). Additionally, following the Beataalk intervention, participants showed significant decrease in both measurements of fundamental frequency (F_0) disturbance: shimmer which relates to the amplitude variation (from 5.3 to 3.5%) and jitter which defines frequency variation from cycle to cycle (from 1 to 0.5%). The shimmer changes with the reduction of glottal resistance and correlates with the presence of noise emission and breathiness. Importantly, the mean final shimmer value is considered within normal range for healthy speakers (< 3.69%; Maryn *et al.* 2009). The jitter is affected mainly by the lack of vocal folds' vibratory control. Patients with vocal pathologies often have a higher percentage of jitter (Teixeira *et al.* 2013). The mean final jitter value fell within normal range (< 0.7%; Maryn *et al.* 2009). Together, these findings indicate a perceptually better and more stable voice quality.

Pre- to post-treatment vocal changes were also assessed for continuous speech. This analysis indicated that vocal loudness significantly increased (from 73.6 to 79 dB; see Figure 2). This is an important finding with positive clinical implications. In a recent study, Coppens-Hofman and colleagues (2016) noted that in many situations, people with ID often reduce overall vocal loudness, which can negatively affect the quality of the speech signal. The current preliminary result suggests that the Beataalk practice may increase vocal

loudness for continuous speech, positively affecting everyday communication. The increased loudness levels may improve speech intelligibility, as subjective dimensions reflecting voice dynamics (whether the voice is weak or powerful; Hazan and Markham 2004) were found to correlate with intelligibility (see also: Levy *et al.* 2017; Mahler *et al.* 2015).

The fact that the intervention was successfully implemented in a large group and delivered by SLP students, who received relatively brief training, illustrates its ease of application in everyday clinical practice. The Beataalk intervention includes several promising components of musical interaction which were identified by Johnels *et al.* (2021). Namely, (1) Responsivity of the interaction partner (whether another participant or the research assistant), (2) Singing songs – which was implemented in each session, (3) Structure and predictability of the activities within the practice session, and (4) Therapeutic alliance within the musical interaction – the enjoyable and trusting relationship encouraged better performance.

These results present initial evidence for the beneficial effect of the Beataalk technique as an intervention tool for improving verbal communication of adults with ID and may expand the SLP's toolbox. However, the results of the present study should be interpreted with caution. Since a single group pre-test – post-test design was used, the ability to draw strong conclusions regarding the impact of the intervention is limited. This design was selected as it enabled to avoid a deferral of treatment and an examination of the feasibility of administration. As the sample included adults (> 22 years), their speech and language skills are considered to have plateaued (Fowler *et al.* 1994). Thus, improvements in speech production can cautiously be attributed to the intervention program. Future studies should include a control group, to increase internal and external validity. In addition, the current sample of adults with ID was heterogenous and many background factors were not controlled, for example, ID etiology and comorbidity. Future studies of larger groups are

warranted. Due to logistical limitations, no follow-up evaluation was conducted, thus the stability of improvements over time is not known. Further research including follow-up assessments is called for, to directly assess long-term effects of the Beataalk technique. Finally, this study invites future research with other populations; for example, teenagers and adults with cerebral palsy (see also, Icht 2021) or other neurological conditions, individuals with speech disorders secondary to cranio-facial defects, such as cleft palate, among others.

Disclosure statement

No potential conflict of interest was reported by the authors.

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