https://doi.org/10.46662/jrp.v2iIssue%201.11

Effect of Tapping and Pacing Rate Control Methods on Speech Rate and Intelligibility of Individuals with Spastic and Ataxic Cerebral Palsy

Maria Amjad, Nuzhat-ul-Ain*, & Aisha Sitwat
Centre for Clinical Psychology, University of the Punjab, Lahore, Pakistan

Abstract

The research was aimed to determine the effectiveness of tapping and pacing rate control methods on speech rate and intelligibility of individuals with spastic and ataxic cerebral palsy (CP) having dysarthria. This study was comprised of a sample of ten individuals with Cerebral Palsy having dysarthria (8 spastic dysarthria, 2 ataxic dysarthria) and they were recruited through non-probability purposive sampling strategy. They were distributed into two groups, with 5 participants in each group. Tapping and pacing rate control interventions were provided to group 1 and group 2, respectively. The pre and post speech rates of both groups were determined based on a 2-min recorded spontaneous speech sample. The pre and post intelligibility of both groups were measured by 4 speech pathologists using a 7-point intelligibility rating scale. Both methods resulted in lower speech rate. Pacing rate control method was more effective than the tapping rate control method in improving the word (p<.034*), phrase (p<.039*), and sentence intelligibility (p<.041*). The results indicated that although both methods were effective, the pacing rate control method was more effective than the tapping rate control method in enhancing the speech rate of children with CP. By using these two methods, the speech language pathologist can enhance the intelligibility of individuals with dysarthria, in a short period of time. The protocols of the research should be standardized so that they can be applied to different populations.

Keywords: tapping, pacing, rate control, intelligibility, spastic cerebral palsy, ataxic cerebral palsy

Introduction

Cerebral Palsy (CP) is a group of disorders which affect the movement and posture, specifically disturbing the muscles around mouth and tongue which coordinate speech (National Institute of Neurological Disorders and Stroke, 2023). According to Centre for Disease Control and Prevention (2022), recent population-based studies from around the world report prevalence estimates of CP ranging from 1 to nearly 4 per 1,000 live births or per 1,000 children. According to a study, the prevalence of cerebral palsy in Khyber Pakhtunkhwa, Pakistan was 1.22/1000 live births (Ahmad et al., 2017). Among the children who have cerebral palsy, half of them have dysarthria (Barnard, 2018). Dysarthria is a motor speech disorder that is caused by muscle weakness due to brain damage. Dysarthria affects the articulation and causes a significant decrease in the intelligibility of speech due to the slurred speech (Kirshner & Samuels, 2023). Therefore, individuals with cerebral palsy having dysarthria have issues with oral communication due to decrease in intelligibility of speech. The speech and language

*Correspondence concerning this article should be addressed to Ms. Nuzhat-ul-Ain, Centre for Clinical Psychology, University of the Punjab, Lahore, Pakistan
Email: nuzhatulain4@gmail.com

pathologist also works to increase their intelligibility using various methods. The purpose of this study is to explore the efficacy of two rate control methods on speech intelligibility, rate of speech of individuals with cerebral palsy and see which method is most effective in enhancing the intelligibility of this population (Nordberg et al., 2013).

Dysarthria can cause a reduction in speech rate, irregular prosodic features, and noteworthy intelligibility deficits resulting in a condensed ability to communicate effectively (Duffy, 2019). American Speech-Language-Hearing Association (n.d.) reported that speech intelligibility is based on how clearly an individual speaks and how much of the speech is understandable or comprehensible to a listener If the message of an individual is completely understood, then speech is intelligible and if the message of an individual is not understandable then speech is unintelligible (Bernthal & Bankson, 2017; Yorkston et al., 2010). Slowing the speaking rate is an active therapeutic method for individuals with motor speech disorders (Hustad, 2011; Lansford et al., 2011). Speech rate is assumed to reflect the speed at which an individual executes articulatory movements for speech production and it is expressed in words per minute (wpm) (Abbs, 1988). To calculate the speech rate of an individual, record the speech of an individual talking for a few minutes. Add the number of words in his/her speech, then divide the total number of words by the number of minutes speech took (Bernthal & Bankson, 2017).

Rate control methods may be the most influential single, behaviorally regulating variable for improving intelligibility. They are used to increase the accuracy of articulation and it's also help to coordinate the numerous processes which are related to speech (Duffy, 2019). The individuals with cerebral palsy having dysarthria also have problem with speech rate as they could not control their speech rate so they have poor intelligibility. In order to control their speech rate, different speech control methods are used. The management of palilalia (speech disorder) using pacing board was documented by Helm (1979). The individual with palilalia repeated a word, phrase, or a sentence in a progressively rapid manner, which make that word, phrase or a sentence almost unintelligible. A pacing board is a great way to help move them from only one to two-word utterances to three to four words. To help individual take conversational turns when talking with others. Pacing board is divided into different spaced dividers, the individual taps one section at one time. Once a reduced rate is achieved using the board, the individual can count syllable or word on their fingers and eventually will be able to speak at normal rate without any means of aid (Duffy, 2019). Another method, which is hand tapping, is also used to slow down the rate of speech. The individual tap hand at one time and speak one syllable or a word. Once a reduced rate is achieved using the hand tapping, the individual will be able to speak at normal rate without any use of hand tapping (Duffy, 2019). Therefore, in the present research, tapping and pacing rate control methods were used to control the speech rate and enhanced the intelligibility of individuals with cerebral palsy having dysarthria.

Rational of the Research

The prevalence of cerebral palsy in Khyber Pakhtunkhwa, Pakistan was 1.22/1000 live births (Ahmad, 2017). Around all of the children who have cerebral palsy, half of them have dysarthria (Nordberg et al., 2013). The individuals with cerebral palsy have speech difficulties. Their speech is not intelligible due to dysarthria. The culture and norms of Pakistan are different

from other countries; as in Pakistan people speak Urdu and Punjabi. A limited number of studies have examined the outcomes of treatment approaches for individual with dysarthria (Pennington et al., 2016). In Pakistan, no research has been conducted on dysarthria in cerebral palsy. The rationale behind present study was to develop a session plan to improve the speech rate and enhance the intelligibility in individuals with cerebral palsy having dysarthria, in a short period of time. This study is conducted to find out factors or parameters that change or are more sensitive to rate control methods and help intelligibility of individual having dysarthria. Tapping and pacing are the two methods that were taken from speech rate control methods to evaluate which method was more effective for acquiring the naturalness of speech. Due to the pandemic situation, many SLPs have been taking online sessions and have faced many issues related to intelligibility. By using these two methods, the speech language pathologist can enhance the intelligibility of an individual during online sessions too. The potential benefits of studying speech rate and intelligibility are substantial and research in this area is increasingly attracting the attention of speech language pathologist. Therefore, the aim of this study was to develop a session plan to improve the speech rate and enhance the intelligibility of individuals with cerebral palsy having dysarthria, in a short period of time.

Hypotheses

H1: There is likely to be an effect of tapping rate control method on speech rate and intelligibility of speech of individuals with cerebral palsy having dysarthria.
H2: There is likely to be an effect of pacing rate control method on speech rate and intelligibility of speech of individuals with cerebral palsy having dysarthria.
H3: There is likely to be a significant difference between tapping and pacing rate control methods on speech rate and intelligibility of individuals with cerebral palsy.

Method

Study Design

A pretest-posttest research design was used. The hand tapping rate control method was provided to first group and pacing rate control method was provided to the other group.

Selection and Description of Participants

A sample of individuals with cerebral palsy having dysarthria (already diagnosed by the team of experts at the institute from where the data was collected) was recruited through non-probability purposive sampling strategy. Those participants recruited who had mild to moderate dysarthria, had normal hearing and vision, and could utter sentences. Participants were divided into two groups on the parameters of matching, which included age, gender, type of dysarthria, type of cerebral palsy and the severity of disorder. In first group, 4 boys and 1 girl, between 8 to 15 years old (*M*age: 12.8 years) and in other group, 4 boys and 1 girl, between 9 to 17 years old (*M*age: 12.4 years). Each group contained four individuals diagnosed with spastic dysarthria and one individual diagnosed with ataxic dysarthria. Individual with visual problems, hearing problems and/or other types of speech disorders were excluded.

Measures

To assess the dysarthria, the Radboud Dysarthria assessment test was used in the present research which has 0.85 reliability. Radboud Dysarthria Assessment is a valid test to assess the type of dysarthria (Knuijt et al., 2018).

Procedure

First of all, in the pre assessment phase, the research proposal was approved by the Departmental Doctoral Program Committee. Then e-mails were sent to the authors of the Radboud dysarthria and intelligibility of rating scale, to get permission to use their test and rating scale. Permission was taken from the data collection site prior to the conduction of the research. Consent form was designed in which the title and purpose of the research was explained. The consent forms were signed by the teacher and parents of participants. In addition, a demographic form was also constructed to get important information of the participants. Firstly, Radboud dysarthria assessment test was applied (in 1 session) to identify the dysarthria. Out of these all individuals of cerebral palsy having dysarthria, only those 10 participants were selected who fulfilled the criteria of present research.

The first stage of the research consisted of pre-assessment of the participants regarding their speech rate and intelligibility and it consisted of 1 session for one participant. In this phase, the participants were involved in spontaneous speech to take the speech sample of the participants (turn on a stopwatch, note the time) and the speech sample was recorded in a quiet environment using a recorder on the mobile phone. The letters were made to the name of five speech language pathologists to take the rating of intelligibility. The speech samples of all the participants were converted into laptop and then in the presence of researcher, samples were carefully listened by the speech language pathologists in a noise free room and then they rated the intelligibility of individuals on intelligibility rating scale. Exclude the rating of one SLP because his rating did not inter-relate with the ratings of other SLPs. The speech rate of each participant was measured by dividing the total number of words by the number of 2 minutes (120 seconds).

In the therapeutic stage (second stage), participants were divided into two groups (5 participants in each group). The hand tapping rate control method was used for the 5 participants. In this technique, the participants were asked to tap their hand on a table and on one tap utter one syllable or one word. This technique was provided in 3 sessions. Similarly, for the second group, pacing therapy was provided in three sessions. In this method, the researcher taught the participant to tap his or her fingers on a square for the first word and then he or she tapped his/her fingers on another square and uttered a second word. The home task reviews were taken by each participant in the next session.

In the third stage, post-assessment of intelligibility and speech rate was done by using the same method which was used in pre-assessment. This stage was consisted on 1 session for each participant.

Pre-Assessment Phase of Speech Rate and Intelligibility

To take speech sample from the participants they were involved in spontaneous speech (turn on a stopwatch, note the time) and the speech sample was recorded in a quiet environment using a recorder on the mobile phone. In order to initiate the speech, pictures of commonly

known national places of Pakistan e.g., Badshahi Mosque etc. were shown to the participants and they were asked to talk about the picture.

In the presence of researcher, samples were carefully listened by the four speech language pathologists (having MS degree in Speech and Language Pathology and 3-4 years of clinical experience) in a noise free room and then they rated the intelligibility of individuals on an intelligibility rating scale. The speech rate of each participant was measured by dividing the total number of words by 120 seconds (2 minutes).

Therapeutic Stage

The hand tapping rate control method was provided to first group and the other group was provided pacing rate control method.

Post Assessment Phase of Speech Rate and Intelligibility

In the third stage, post-assessment of intelligibility and speech rate was done by using the same method which was used in pre-assessment.

Ethical Guidelines

- The permission for the approval of the research was taken from the Departmental Doctoral Program Committee, Centre for Clinical Psychology, University of the Punjab, Lahore, Pakistan.
- The written permission from the data collection site was taken after providing them information regarding the study.
- The teacher of the participants was given a consent form and detailed information sheet in which they were provided the main details of the study and information regarding confidentiality. The participant's names were not mentioned anywhere while reporting the results and findings of the study.
- The permission letters were signed by the SLPs to take the intelligibility ratings.
- The audio of the participants was listened by the SLPs in the presence of the researcher.
- The procedures of the sessions were discussed with the teachers of the participants.
- Every participant had right to quit the study whenever he/she wanted.

Results

The following section represents the results of the present study.

Table 1

Differences In Pre and Post Scores of Individuals Receiving Tapping Rate Control Method

Variables	Before Treatment *(Mdn)*	After Treatment *(Mdn)*	*Z*	*p*
Word intelligibility	7.00	4.00	-1.89	.059
Phrase intelligibility	7.00	4.00	-1.86	.063
Sentence intelligibility	7.00	5.00	-1.84	.066
Speech rate	1.51	.98	-2.02	.043*

Note: *p< .05, Mdn= Median Rank

Table 1 depicts the pre and post assessment scores of the participants who received tapping rate control method. Wilcoxon Signed Rank test was done to measure the treatment efficacy. The analysis showed that there was no statistically significant difference in word intelligibility, phrase intelligibility and sentence intelligibility of pre and post treatment of individuals who received tapping rate control method. However, research showed that the rate control methods had a significant clinical impact as the word phrase and sentence intelligibility of four out of five individuals was improved as indicated by the significant difference between pre and post speech rate scores with (*z*= -2.02) and (*p*= .043). The median score of speech rate also reduced from *Md*= 1.51(pre-treatment) to *Md*= .98 (post-treatment).

Table 2

Differences in scores of Pre and Post Treatment of individuals who received Pacing rate control method (N=5)

Variables	Before Treatment *(Mdn)*	After Treatment *(Mdn)*	*Z*	*p*
Word intelligibility	5	3	-2.12	.034*
Phrase intelligibility	6	3	-2.06	.039*
Sentence intelligibility	6	3	-2.04	.041*
Speech rate	1.13	.880	-2.02	.043*

Note: *p< .05, *Mdn*= Median Rank

Table 2 depicts the results of a statistically significant difference between pre and post scores. The median rank of word, phrase and sentence intelligibility has decreased from Pre-Treatment to Post-Treatment. The median rank of speech rate was increased from Pre-Treatment (*Md*= 1.13) to Post-Treatment (*Md*= .880).

To compare the effectiveness of Tapping and Pacing Rating Control Methods, Mann Whitney U test was run.

Table 3

Mann Whitney U Test for comparing post treatments of both groups (N=10)

Variables	Tapping *(Mdn)*	Pacing *(Mdn)*	*Z*	*p*	*r*	*U*
Word intelligibility	4	3	-2.15	.032*	0.68	3
Phrase intelligibility	4	3	-1.64	0.10	0.52	5
Sentence intelligibility	5	3	-1.84	.065	0.58	4
Speech rate	.98	.880	-.629	.053	1.99	9.5

Note. **p*<.05, *r*= Effect Size, *U* = Maan Whitney

The results of Table 3 (Mann-Whitney *U* Test) revealed that the word intelligibility was significantly greater for the participants using pacing method (*Mdn*=3, *n*=5) than for the participants using tapping method (*Mdn*=3, *n*=5). However, there were non-significant differences on phrase intelligibility, sentence intelligibility, and speech rate.

Discussion

The present research is matched participants in both groups to find out the effectiveness of specific rate control method while in the previous research, twelve individuals were divided into two groups, only on the basis of disorder's severity (Hustad, 2011; Jackson, 2021). In the present research, it was hypothesized that there would be a difference of tapping rate control method on pre and post assessment of speech rate and intelligibility of individuals with cerebral palsy having dysarthria. The present research partially fulfilled that hypothesis. In the present research, a pre and post difference in speech rate among individuals with cerebral palsy was observed. It was also noted that there was no effect of tapping rate control method on the intelligibility of these individuals. The previous research conducted by Van Nuffelen et al. (2010), on the efficacy of rate control on speech production and intelligibility in dysarthria, supports the result in present study. In this study, the author used different rate control methods, including voluntary, alphabet board, hand tapping method, delayed auditory feedback and pacing board method. Out of those methods, the most effective methods to improve speech intelligibility were alphabet board, hand tapping and pacing board but it was improved only in 6 out of 27 participants (Van Nuffelen et al., 2010).

In the present study, the second hypothesis stated there is likely to be an effect of pacing rate control method on speech rate and intelligibility of speech of individuals with cerebral palsy having dysarthria. The tapping method did not show significant result but the pacing method showed significant results for overall intelligibility on word, phrase and sentence level. The study by Van Nuffelen et al. (2010) also reported that the pacing method significantly enhance the speech intelligibility and reduced the speech rate. Pacing helps an individual to break the speech into segments, which often results in increasing intelligibility. Blanchet and Snyder (2010) reported that pacing methods helped in improving speech post treatment. This research also recommended the use of a pacing board as a rate control therapy as it is relatively easy to use, have low cost and require minimal training. Furthermore, Knowles et al. (2021) also reported that slower than habitual speech rate can significantly enhances one's speech intelligibility. In present research, four SLPs who were experienced in dysarthria listened the participant's recording and rate them, furthermore, all the parameters were kept same in both groups, which strengthen the results of present research. The present research checked and compared the findings of pre and posts both assessments and also found out that pacing rate control method is better in enhancing the intelligibility of individuals with cerebral palsy.

Conclusion

It was concluded that there were differences in pre and post speech rate of individuals with cerebral palsy having dysarthria. The findings of the present research concluded that the intelligibility of the individuals with cerebral palsy has been improved after the treatment of pacing and tapping rate control method. The present research also indicated that the use of pacing rate control method is more effective rather than the tapping rate control method to enhance the intelligibility of individuals with cerebral palsy having dysarthria.

Limitations and Suggestions

The sample size was small because data was collected during the first wave of COVID-19. There was limited time to conduct the study so the researcher could collect data from only

one institute which indicates that the research could have low generalizability. By using these two methods, the speech language pathologist can enhance the intelligibility of individuals with dysarthria in a shorter period of time. Future researches should be focused on these techniques on the larger sample size to increase the generalizability.

Implications

The present research focused on the two specific techniques i.e., tapping and pacing, and it was found that they were effectiveness in improving the intelligibility of sample with cerebral palsy having spastic and ataxic dysarthria. The present study provides evidence for speech and language pathologists that these methods can be effectively used to manage dysarthria in individuals with cerebral palsy. Furthermore, these methods are low cost and requires minimal training. Furthermore, speech and language pathologists can also adapt these methods in online setting which further proves the value of these methods.

References

Abbs, J. H., & Gracco, V. L. (1988). Characteristics of speech as a motor control system. *Advances in Psychology*, 3–28. https://doi.org/10.1016/s0166 4115(08)60644-5

Ahmad, A., Akhtar, N., & Ali, H. (2017). Prevalence of cerebral palsy in children of district Swabi, Khyber Pukhtunkhwa, Pakistan. *Khyber Medical University Journal, 9*(2), 88-91.

American Speech-Language-Hearing Association. (2016). *Scope of practice in speech language pathology.* https://doi:10.1044/policy.SP2016-00343

American Speech-Language-Hearing Association. (n.d.). *Speech sound disorders: articulation and phonology.* https://www.asha.org/Practice-Portal/Clinical-Topics/Articulation-and-Phonology/

Barnard, D. (2018). *Average speaking rate and words per minute. average speaking rate and words per minute.* https://virtualspeech.com/blog/average-speaking-rate-wordsper-minute

Bernthal, J. E., & Bankson, N. W. (2017). *Articulation and phonological disorders: Infancy through adulthood* (5th ed.). Allyn & Bacon.

Blanchet, P. G., & Snyder, G. J. (2010). Speech rate treatments for individuals with dysarthria: A tutorial. *Perceptual and Motor Skills, 110*(3), 965–982. https://doi.org/10.2466/pms.110.3.965-982

Centers for Disease Control and Prevention. (2022, May 2). *Data and statistics for cerebral palsy.* https://archive.cdc.gov/www_cdc_gov/ncbddd/cp/data.html

Duffy, J. R. (2019). *Motor speech disorders: Substrates, differential diagnosis, and management* (4th ed.). Elsevier Health Sciences.

Helm, N. (1979) Management of palilalia with a pacing board. *Journal of Speech and Hearing Disorders, 44*, 350-353.

Hustad, K. C. (2011). The Relationship between listener comprehension and intelligibility scores for speakers with dysarthria. *Journal of Speech, Language, and Hearing Research, 51*(3), 562–573. https://doi.org/10.1044/1092-4388 (2008/040)

Jackson, A. C. (2021). *The effect of rate control cueing modality on articulatory patterns*. Brigham Young University.

Kirshner, H. S., & Samuels, M. A. (2023). Speech and language disorders. In E. E. Zimmerman, M. A. Samuels, H. S. Kirshner, K. E. Misulis (Eds.), *Neurologic localization and diagnosis: Differential diagnosis by complaint-based approach* (pp. 177-189). Elsevier. https://doi.org/10.1016/C2020-0-00740-1

Knowles, T., Adams, S. G., & Jog, M. (2021). Variation in speech intelligibility ratings as a function of speech rate modification in Parkinson's disease. *Journal of Speech, Language, and Hearing Research, 64*(6), 1773–1793. https://doi.org/10.1044/2021_jslhr-20-00593

Knuijt, S., Kalf, J. G., Van Engelen, B. G., De Swart, B. J., & Geurts, A. C. (2017). The radboud dysarthria assessment: Development and clinimetric evaluation. *Folia Phoniatrica Et Logopaedica, 69*(4), 143–153. https://doi.org/10.1159/000484556

Lansford, K. L., Liss, J. M., Caviness, J. N., & Utianski, R. L. (2011). A cognitive-perceptual approach to conceptualizing speech intelligibility deficits and remediation practice in hypokinetic dysarthria. *Parkinson's Disease, 150962.* https://doi.org/10.4061/2011/150962

National Institute of Neurological Disorders and Stroke, (2023, November 28). *Cerebral Palsy*. https://www.ninds.nih.gov/health-information/disorders/cerebral-palsy

Nordberg, A., Miniscalco, C., Lohmander, A., & Himmelmann, K. (2013). Speech problems affect more than one in two children with cerebral palsy: Swedish population-based study. *Acta Paediatrica, 102*(2), 161–166. https://doi.org/10.1111/apa.12076

Pennington, L., Parker, N. K., Kelly, H., Miller, N. (2016). Speech therapy for children with dysarthria acquired before three years of age. *Cochrane Database of Systematic Reviews*. https://doi.org/10.1002/14651858.CD006937.pub3

Van Nuffelen, G., De Bodt, M., Wuyts, F., & Van de Heyning, P. (2010). The effect of rate control on speech rate and intelligibility of dysarthric speech. *Folia Phoniatrica et Logopaedica, 61*(2), 69–75. https://doi.org/10.1159/000208805

Yorkston, K. M., Beukelman, D. R., Strand, E. A., & Hakel, M. (2010). *Management of motor speech disorders in children and adults* (3rd ed.). Pro-Ed.