NONWORD REPETITION ABILITY OF CHILDREN WHO DO AND DO NOT STUTTER AND COVERT REPAIR HYPOTHESIS

MEHDI BAKHTIAR, DEHQAN AHMAD ABAD ALI, SEIF PANAHI MOHAMMAD SADEGH

ABSTRACT

CONTEXT: Stuttering has a life span incidence and it significantly impacts academic, social, emotional and vocational achievements of patients who stutter. AIMS: The purpose of the present study was to examine phonological encoding in young children who stutter (CWS) during a nonword repetition task and to test the covert repair hypothesis (CRH) and phonological skills in Persian native children. SETTING AND DESIGN: The study was conducted among 12 CWS and 12 children who do not stutter (CWNS) between the ages of 5.1 and 7.10 at the rehabilitation clinics in Tehran. MATERIALS AND METHODS: A list of 40 bisyllabic and trisyllabic nonwords was used in a nonword repetition task to collect information about the following dependent variables: (a) reaction times (RTs), (b) the number of phonological errors (PEs) and (c) nonword length. DATA ANALYSIS: An independent sample T-test was performed to compare means of PEs and RTs between the two groups and a paired t-test for analysis of nonword length impacts. RESULTS: Results indicated that the CWS had a slightly poor performance than CWNS but there was no significant difference between the groups. Also, the differences between bisyllabic and trisyllabic nonwords were significant for phonological errors but not for reaction times. CONCLUSION: In general, it is concluded that CWS might not have a gross problem in phonological retrieval of the novel phonological context even with increase in syllable length. Also, some predictions of CRH were not supported by this research. However, further research into this possibility may shed light on the emergence and characteristics of childhood stuttering.

Key words: Children who stutter, nonword repetition, phonological errors, reaction time, stuttering

Generally, a large number of researchers believed that individuals who stutter (IWS) have difficulty in formulating speech motor plans due to deficit in timing and/or coordinating speech musculature.^[1-4] Some other recent

Department of Speech Therapy, Faculty of Paramedicine, Zahedan University of Medical Sciences, Zahedan, Iran

Correspondence:

Dr. Mehdi Bakhtiar, Dept. of Speech Therapy, Faculty of Paramedicine, Zahedan University of Medical Sciences, Zahedan, Iran. E-mail: mbakhtiar@zdmu.ac.ir

empirical studies on children who stutter (CWS)^[5-13] suggest that linguistic issues in CWS may be somewhat different from children who do not stutter (CWNS). Arguably, further investigation in this area of research should provide specifically meaningful insight into whether some parts of the linguistic processes are involved in the initiation and maintenance of stuttering in young children.^[14]

Psycholinguistic theories suggest that stuttering

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begins during speech planning, i.e., prior to the execution of speech.^[7,15] Among these theories, the Covert repair hypothesis (CRH), by Kolk and Postma 1991-1997, is one of the most comprehensive explanations of stuttering.^[16] CRH suggests that instances of stuttering result from deficit in the phonological loop of speech-language planning and that the IWS produce more phonological errors than individuals who do not stutter (IWNS). Essentially, a slow phonological system may result in increased errors, a higher need for self repairs and interruption in flow of speech production and ultimately occurrence of stuttering symptoms.^[17]

In order to validate this hypothesis, Postma et al.[18] investigated speaking rates of 19 IWS and 19 IWNS using tongue-twister sentences and matched control sentences spoken either silently, lipped or overtly to examine phonological encoding. The results suggested that IWS were slower than IWNS, not just in overt speech but also in silent speech tasks involving linguistic processes which were considered to involve minimally negligible motor planning and execution. Some studies also consider examination of the linguistic problems, especially phonological ones, in stuttering by designing priming tasks.^[7,10,11,15] Some other studies attend to these problems in the nonword repetition tasks. As it is mentioned in the literature, nonword repetition is an area of weakness in children with specific language impairment,^[19-21] but some recent studies indicated this in the CWS.

Hakim and Ratner^[22] assessed nonword repetition ability of 8 CWS and 8 CWNS on 2-5 syllable nonwords. Results indicated that CWS had significant weakness in terms of number of phoneme errors at trisyllabic nonwords but not on the others. In a similar study, Anderson *et al.*^[23] investigated nonword repetition skills in younger CWS and CWNS (3.0 and 5.2 years old). These findings revealed that CWS produced significantly fewer correct nonwords and made significantly more phoneme errors on nonword repetitions relative to CWNS. Generally, it has been hypothesized that nonword repetition has emerged as a more sensitive measure of children's linguistic abilities, especially phonological skills.^[20-23]

Hence the purpose of this study was to investigate phonological skills in young CWS and also to examine the CRH by measuring a) reaction times (RTs) and b) phonological errors (PEs) through a nonword repetition task involving bisyllabic and trisyllabic nonwords.

MATERIALS AND METHODS

This case-control study was performed from March 2006 to January 2007 in Tehran rehabilitation clinics. Participants consisted of 12 CWS (8 males, 4 females) and 12 CWNS (8 males, 4 females); all the participants were monolingual and native speakers of Persian language. Participants were between the ages of 5.1 and 7.10 (CWS: M = 6.3, SD = 8.5; CWNS: M = 6.4, SD = 7.5). No significant difference was found between ages of two groups.

All the participants had to meet the following criteria: healthy auditory system; and normal language, articulation and short-term (immediate) memory abilities.

Scoring of these criteria in this study was

undertaken by test of language development^[24] (TOLD: P (3), Persian version). Therefore, auditory discrimination subtest was assigned for assessment of auditory system; phonetic evaluation subtest for articulation assessment; and sentence imitation, grammatical understanding and phonological analysis subtests were used for evaluation of language ability. Also, the ability of short-term memory was obtained by measuring the amount of digit span.

A 15-min speech sample based on serial picture descriptions between the child and examiner was also included for determination of the child as a stutterer. Hence a child was classified as a stutterer by a speech and language pathologist if (a) he/she exhibited 3 or more within-word disfluencies (i.e., sound prolongations, sound/ syllable repetitions, monosyllabic whole-word repetitions or broken words) per 100 words (b) people in his/her environment had expressed concern regarding his/her speech fluency. These procedures also were considered for CWNS; and if they exhibited fewer than 3 stuttering-like disfluencies per 100 words of conversational speech and none of the parents of these children expressed concern about their child's speech fluency, the child was classified as a nonstutterer. Also, it should be remembered that 8 children who did not satisfy the required criteria had been excluded from the study, and all the subjects in CWS group had undergone at least a short period of traditional speech and language therapy (3 months) and were still stuttering during the time of conducting research.

For the present study a word list containing 40 nonwords, 20 bisyllabic [âlpun* - qeydak*] and 20 trisyllabic [Delaxfân* - Šepâxat*], was used [Appendix 1]. These nonwords were generated from bi- and trisyllabic Persian language words by changing one or two consonants in them until they could not convey the semantic issues of the word. Also, the phonetic structure of the nonwords conformed to the usual Farsi pattern. The nonwords included a variety of phonemes and syllables in the Persian language (cv, cvc, cvcc) and all the sounds and

Appendix 1: List of research nonwords with their syllable sequence

| Two syllables | Syllable sequence | Three syllables | Syllable sequence |
|---------------|-------------------|-----------------|-------------------|
| Alpun | CVC.CVC | Delakhfan | CV.CVC.CVC |
| Antur 6 | CVC.CVC | Miranchi | CV.CVC.CV |
| Gardom | CVC.CVC | Bishkulit | CVC.CV.CVC |
| Juke | CV.CV | Chakafol | CV.CV.CVC |
| Gurab | CV.CVC | Dimache | CV.CV.CV |
| Lishan | CV.CVC | Fazherab | CV.CV.CVC |
| Nazin | CV.CVC | Gofayesh | CV.CV.CVC |
| Sharyal | CVC.CVC | Hafasi | CV.CV.CV |
| Khalgish | CVC.CVC | Jamefar | CV.CV.CVC |
| Qeydak | CVC.CVC | Khejamat | CV.CV.CVC |
| Pilchan | CVC.CVC | Morfalid | CVC.CV.CVC |
| Molakh | CV.CVC | Naporost | CV.CV.CVCC |
| Mejak | CV.CVC | Palashin | CV.CV.CVC |
| Kedrit | CVC.CVC | Reqhamat | CV.CV.CVC |
| Jelid | CV.CVC | Shepakhat | CV.CV.CVC |
| Gelakht | CV.CVCC | Vazerin | CV.CV.CVC |
| Deyshi | CVC.CV | Vekarat | CV.CV.CVC |
| Amar | CV.CVC | Yasanin | CV.CV.CVC |
| Same | CV.CV | Zhelapin | CV.CV.CVC |
| Saqat | CV.CVC | Oqlamus | CVC.CV.CVC |

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sample T-test to compare PEs and RTs of CWS

and CWNS. Also, paired t-test was undertaken

for analysis of nonword length impacts on PEs

Descriptive results of participants for including

in the study [Table 1] were as follows: Mean

standard scores of TOLD:P(3): on sentence

imitation, 16.5 for CWS group (SD: 2.8) and

15.8 for CWNS group (SD: 2.1); on grammatical

understanding, 14.5 for CWS group (SD: 1.86)

and 15.8 for CWNS group (SD: 2.14); on

phonological analysis, 10 for CWS (SD: 0.8)

and 12.5 for CWNS group (SD: 1.72); on word

discrimination, 12 for CWS group (SD: 1.13)

and 13 for CWNS group (SD: 1.86); and on

phonetic evaluation, 17.5 for CWS group (SD:

1.2) and 16.8 for CWNS group (SD: 0.9). Also,

mean of digit span score for CWS was 3.9 (SD:

0.48); and for CWNS, it was 3.8 (SD: 0.68). The

score differences between two groups did not

indicate any differences between their abilities

and RTs in all subjects.

RESULTS

in those areas.

sound combinations appropriately adapted for 30 children aged 5-8 years who had not any articulation, auditory and fluency problems in pilot study. At least, 40 nonwords which were repeated correctly (just at the first attempt) by them in a 'without time pressure' condition were selected for using in the experiment.

Stimuli presentation and data recording were operated by DMDX through a laptop computer. DMDX is an experimental linguistic software that presents the audio and video files with millisecond accuracy and estimates the RTs of the received responses to them.^[25] In the present study, with DMDX, nonwords were presented aurally and also RT of the nonword repetition was recorded for each subject. In front of each child, there was a microphone that received the voice of the child. Whenever the child began to repeat nonwords, DMDX measured and recorded the time interval between the nonword presentation and initiation of the nonword repetition by him/her. All 40 nonwords had been recorded as computer-based voice files through the Cool Edit software (2000 version) and adjusted for noise and duration. Also, the volume level was adjusted to a level the child deemed most comfortable. Determined time out for each response was 3,000 ms; and if the child did not respond to the item during this time period, the next item was presented automatically by DMDX. Also, there was a break between bisyllabic and trisyllabic presentations, until the children could have a good performance on both parts of the nonword task.

Procedure

The participants were examined in a quiet setting in one session lasting approximately 1-1.5 h. In order to ensure a fresh state of mind in the

children, we performed the experiment in the morning for all the subjects. All the stimuli were presented 'free field' (i.e., without headsets) to avoid increasing stress level for children and also because some of the younger children could not bear wearing them in the extended time of the task performance. Then, the examiner gave the following instructions to the children: 'I want to say some funny and silly made-up words to you. Repeat them after me exactly the way that I say them as soon as possible.' Five examples of nonsense words in each length (bi- and trisyllabic) were given as trials, and the child was asked to repeat them. As previously stated, RTs were recorded by DMDX, and all the responses were audio-taped for measuring the number of PEs. At first, each incorrect nonword was marked and its individual phoneme errors such as substitutions and omissions determined. Then, the total number of PEs was calculated by counting the number of PE/PEs in each individual nonword. Any wrong data due to stuttering occurrence at the time of repetition and missing attention of the child to the presented stimulus was marked by the examiner and, after finishing the test, excluded from the obtained data. Also, error and disfluency counts were performed again by another speech pathologist who was not a part of the study and had enough experience in this work. Final decision in this area was taken based on their agreement on the number of errors and disfluencies.

The study was approved by the local ethic committee, and informed consent was taken from the parents of patients and healthy control subjects.

Statistical analysis

Data analysis was performed by independent

Table 2: Mean and standard deviation of reaction times and phonological errors in nonword repetition task

| Bisyllabic | | Trisyllabic | | Bisyllabic | | Trisyllabic | | |
|------------|-----------------|---|-----|------------|---|---|--|--|
| F | RT | | RT | | PE | | PE | |
| М | SD | М | SD | М | SD | М | SD | |
| 594.69 | 110.2 | 568.6 | 120 | 5.33 | 1.8 | 7.1 | 4 | |
| 540.8 | 94.5 | 530.3 | 105 | 3.75 | 1.9 | 5.1 | 2.9 | |
| | 594.69 540.8 | RT M SD 594.69 110.2 540.8 94.5 | | | $ \frac{RT}{M} \frac{RT}{594.69} \frac{RT}{110.2} \frac{RT}{530.3} \frac{RT}{105} \frac{RT}{3.75} $ | RT RT PE M SD M SD M SD 594.69 110.2 568.6 120 5.33 1.8 540.8 94.5 530.3 105 3.75 1.9 | RT RT PE M SD M SD M 594.69 110.2 568.6 120 5.33 1.8 7.1 540.8 94.5 530.3 105 3.75 1.9 5.1 | |

*RT - Reaction time, †PE - Phonological error

The purpose of this study was to examine the a) differences between CWS and CWNS in the number of phoneme errors and reaction times and b) the effect of word length on these variables in a nonword repetition task.

The mean and standard deviation of two groups in different items of the test are indicated in Table 2. As determined, there are some differences between the two groups; CWS have a slightly weak performance than CWNS, but these differences are not statistically significant [Table 3, P > 0.05]. It is obvious from Table 2 that both groups indicated a relatively similar performance on the rate of bisyllabic and trisyllabic RTs and number of PEs [Figures 1 and 2].

Also, the effect of nonword length on the number of PEs and the rate of RTs in bisyllabics and trisyllabics [Table 4, Figures 3 and 4] in all subjects indicated a slightly more mean of RTs for bisyllabics and more mean of PEs for trisyllabic repetitions. However, the mean difference in this area was not significant for

Table 1: Descriptive results of the two groups on different items of inclusion criteria, besides their statistical differences

| | Age | SI | GU | PA | WD | PE | DS |
|-------------|---------|----------|----------|----------|--------|----------|----------|
| · S | M SD | M SD | M SD | M SD | M SD | M SD | M SD |
| Stutters | 6;3 8.5 | 16.5 2.8 | 14.5 1.8 | 10 0.8 | 12 1.1 | 17.5 1.2 | 3.9 0.4 |
| Nonstutters | 6;4 7.5 | 15.8 2.1 | 15.8 2.1 | 12.5 1.7 | 13 1.8 | 16.8 0.9 | 3.8 0.68 |
| Sig. | 0.851 | 0.89 | 0.88 | 0.7 | 0.79 | 0.84 | 0.9 |

*SI - Sentence imitation, †GU - Grammatical understanding, ‡PA - Phonological analysis, [§]WD - Word discrimination, ^{II}PE - Phonetic evaluation, ¹DS - Digit span

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Table 3: Independent sample t-test results for between-group differences in reaction times and phonological errors

| | Mean | 95% CI | | Т | df | Sig. |
|----------------|-------------|--------|-------|------|----|------|
| | Differences | L | U | | | |
| Bisyllabic RT | 70.44 | -26.13 | 167 | 1.51 | 22 | 0.52 |
| Trisyllabic RT | 50.33 | -68.29 | 168.9 | 0.88 | 22 | 0.42 |
| Bisyllabic PE | 1.58 | -1.56 | 3.32 | 1.88 | 22 | 0.8 |
| Trisyllabic PE | 1.16 | -2.46 | 4.8 | 0.66 | 22 | 0.9 |

*RT - Reaction time, [†]PE - Phonological error

| Table 4: Paired t-test results for bisyllabic and trisyllabic reaction time a | and phono | logical error | differences in |
|---|-----------|---------------|----------------|
| all subjects | | | |



Figure 1: Reaction time comparison between the two groups across bisyllabic and trisyllabic nonwords (*RT2: Bisyllabic reaction times; †RT3: Trisyllabic reaction times; ‡CWS: Children who stutter; "CWNS: Children who do not stutter)

rate of RTs (P = 0.3) but was significant for the number of PEs (P = 0.02).

DISCUSSION

In general, the present study was intended partially to investigate the findings of Hakim and Ratner^[22] and Anderson *et al*.^[23] in Persian language. Our findings were similar to those of Hakim and Ratner, in part, with respect to **Figure 2:** Phonological errors comparison between the two groups across bisyllabic and trisyllabic nonwords (*PE2: Bisyllabic phonological errors; [†]PE3: Trisyllabic phonological errors; [‡]CWS: Children who stutter; ^{II}CWNS: Children who do not stutter)

2-, 4- and 5-syllabic nonwords. As in the same study, in this study the CWS did not commit significantly more errors than did the CWNS. However, unlike the findings by Hakim and Ratner, the findings of the present study did not indicate a significant difference with respect to trisyllabic nonwords too. Also, the research result was not in agreement with that of the other study of nonword repetition by Anderson *et al.*^[23] with respect to the number of phonological errors.



Figure 3: Phonological errors comparison between bisyllabic and trisylabic nonwords in all subjects (*PE2: Bisyllabic phonological errors; [†]PE3: Trisyllabic phonological errors)



Figure 4: Reaction time comparison between bisyllabic and trisyllabic nonwords in all subjects (*RT2: Bisyllabic reaction times; †RT3: Trisyllabic reaction times)

This study indicated that younger CWS (ages 3.0 and 5.2) differed from their peers in nonword repetition and phonological skills.

Thus, based on these two studies, perhaps it could be suggested that phonological ability of children may be somewhat different with increase in their age. Also, this point was confirmed by our study too, and the children in greater age range (ages 5.1 and 7.10) compared to those in

the study by Anderson et al. had less difficulty in phonological retrieval in nonword repetition task.

On the other hand, results with respect to RTs of nonword repetition task did not match with the results of the study by Kolk *et al.* regarding speed of phonological encoding too. Perhaps, those results may have arisen from defect in the other parts of linguistic processing but not phonological ones.

Despite the descriptive differences between CWS and CWNS on the RTs and PEs items, this study could not approve significantly the CRH assumption by using a nonword repetition task. In other words, the prediction of the CRH that CWS appear significantly more delayed on word production (due to defect in phonological planning) and commit more phonological errors was not supported.

As it was noted on the RTs' and PEs' comparisons between bisyllabic and trisyllabic nonwords, with increase in RTs' mean, the PEs' mean decreased. In other words, with decrease in time period of nonword repetition (RTs' mean), as a rule, accuracy level in phonological retrieval has decreased. Therefore, based on these results, the prediction of the CRH that phrases which are produced more rapidly involve more errors and phonological problems was supported, and the relationship between nonword length and phonological errors was confirmed too.

Generally, in interpreting these findings from the Persian native children, it may be tempting to infer that CWS, unlike the children with specific language impairment, might not have a gross weakness in the area of phonological skills and perhaps it could be stated that there is a subtle weakness that could differ from one language to another. In addition, TOLD results on phonological analysis also did not confirm the existence of a significantly different phonological ability in this area between CWS and CWNS. Perhaps, it can be suggested that the other components of linguistic processing involved in word production (apart from phonological ones) need to be investigated further. By the way, more researches in this area with a larger sample size and in other languages may help to confirm this and shed light on the phonological skills and linguistic characteristics of childhood stuttering.

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Announcement

Dr. J. C. Patel Birth Centenary Celebration Committee

The year 2008 is the Birth Centenary Year of Dr. J. C. Patel. Some of his students/admirers felt that it would be a good idea to celebrate this Centenary Year by organizing CMEs, Orations/Lectures, Conferences, etc. during the year. He was associated with many professional bodies, which meet regularly every year; during these annual meetings/conferences, a lecture/symposium, etc can be organized as a part of Centenary celebrations. We would like to form a Dr. J. C. Patel Birth Centenary Celebrations Committee. All his past students/admirers are invited to join the committee (without any financial commitment). Kindly communicate your name, designation, postal address, telephone number and E-mail ID to Dr. B. C. Mehta at Flat 504, Prachi Society, Juhu-Versova Link Road, Andheri (W), Mumbai 400 053 (drmehta.bc@gmail.com).

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