ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

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Relationships Between Stuttering Behaviours, Physical Tension, Oral-Diadochokinetic Rates, and Unhelpful Thoughts and Beliefs About Stuttering in Adults Who Stutter

Kekemeliği Olan Erişkinlerde Kekemelik Davranışları, Fiziksel Gerilim, Oral Diadokokinetik Hız ve Kekemelikle İlgili Yardımcı Olmayan Düşünceler ve İnançlar Arasındaki İlişkiler

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ABSTRACT Objective: This study examines the relationships between stuttering behaviour, physical tension, oral-diadochokinetic (oral-DDK) rate, and Unhelpful Thoughts and Beliefs about Stuttering-Turkish Version (UTBAS-TR) scores. As another objective, it aims to examine the variables predicting secondary behaviours. **Material and Methods:** The study included 28 adults who stutter. Stuttering behaviours were evaluated through the Stuttering Severity Instrument-4 protocol. Physical tension was evaluated perceptively by three raters. Oral-DDK production was calculated by the PRAAT software. Cognitions about stuttering were evaluated with UTBAS-TR. The correlation among variables and their levels of prediction of secondary behaviours were analyzed. **Results:** All UTBAS-TR scores showed a significant positive correlation with duration, whereas they were negatively and significantly correlated with the /paka/ syllable's oral-DDK rate. Except for the UTBAS-TR-I (frequency) score, other UTBAS-TR scores showed a negative correlation on a significant level with the oral-DDK rate of the /pata/ syllable. The percentage of stuttered syllables (SS%) and UTBAS-TR-III (anxiety) scores also showed a significant positive correlation. Additionally, it was found that physical tension had a predictive effect on secondary behaviours ($p<0.05$). **Conclusion:** Evidence is provided on how motor and psychological factors interact with stuttering. Moreover, it is seen as important in terms of the clinical sense as the theoretical sense that the relationships shown by the symptoms and tension predicted secondary behaviours.

Keywords: Stuttering behaviours; oral-diadochokinetic rate; unhelpful thoughts and beliefs

ÖZET Amaç: Çalışmanın amacı; kekemelik davranışları, fiziksel gerilim, oral-diadokokinetik (oral-DDK) hız ve Kekemelikle İlgili Yararlı Olmayan Düşünceler ve İnançlar-Türkçe Versiyonu [Unhelpful Thoughts and Beliefs about Stuttering-Turkish Version (UTBAS-TR) ölçeğinin skorları arasındaki ilişkinin incelenmesidir. Diğer amaç ise ikincil davranışları yordayan değişkenlerin incelenmesidir. **Gereç ve Yöntemler:** Çalışmaya, kekemeliği olan 28 erişkin birey katılmıştır. Kekemelik davranışları, Kekemelik Şiddeti Değerlendirme Aracı-4 protokolü temel alınarak değerlendirilmiştir. Fiziksel gerilim, üç değerlendirici tarafından algısal olarak değerlendirilmiştir. Oral-DDK üretimleri, PRAAT ile analiz edilerek hesaplanmıştır. Kekemeliğe ilişkin bilişler UTBAS-TR ile değerlendirilmiştir. Değişkenlerin birbirleriyle ilişkisi ve bu değişkenlerin ikincil davranışları yordama düzeyleri incelenmiştir. **Bulgular:** Tüm UTBAS-TR skorları, süre ile anlamlı düzeyde pozitif ilişkili ve /paka/ hecesindeki oral-DDK hızı ile negatif ilişkili bulunmuştur. UTBAS-TR-I (frekans) skoru hariç diğer UTBAS-TR skorları da /pata/ hecesinin Oral-DDK hızıyla anlamlı düzeyde negatif ilişkiye sahiptir. Konuşmanın kekelenen hece yüzdesi ile UTBAS-TR-III (anksiyete) skoru da anlamlı pozitif korelasyon göstermiştir. Ayrıca fiziksel gerilim değişkeninin ikincil davranışlar üzerinde yordayıcı etkisi olduğu bulunmuştur ($p<0,05$). **Sonuç:** Motor ve psikolojik faktörlerin kekemelikte nasıl bir etkileşim sergilediğine dair kanıtlar sunulmuştur. Ayrıca belirtilerin sergilediği ilişkiler ve gerilimin ikincil davranışları yordayor olması kuramsal açıdan olduğu kadar klinik açıdan da önemli görülmektedir.

Anahtar Kelimeler: Kekemelik davranışları; oral-diadokokinetik hız; yardımcı olmayan düşünceler ve inançlar

Stuttering has been studied by researchers for many years from linguistic, motoric, cognitive, neurological, auditory, psychological perspectives or through multi-factor models, including various combinations of these.[1] Many researchers are certain that these factors play a role in stuttering, yet it is not clear

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how they interact at various stages.[2,3] In this way, it has also been reported that there may be some subtypes in stuttering.[4,5]

In the literature, it is seen that motor functions prevail in the explanation of stuttering.[6,7] Stuttering from a motor perspective, is a failure to sustain airflow that occurs due to disturbed muscle activity in the laryngeal system and uncoordinated timing in the articulatory movements.[8,9] Many authors have examined physical tension related to stuttering in various contexts.[10,11] The presence of these abnormal movements leads to physical tension in various parts of the body, especially larynx and articulators such as lips, tongue, and jaw.[1,3] Studies on laryngeal muscle activation in people who stutter (PWS) have demonstrated that there is intense laryngeal muscle activity during stuttering behaviour and poor coordination of muscles with the opposite function.[12-14] Also, many authors advocate the hypothesis that PWS have difficulty in initiating and controlling speech movements.[15,16]

Kinematic or acoustic measurements are used in studies evaluating the motor skills of speech in stuttering.[17-20] Oral-diadochokinetic (oral-DDK) rate skill is the ability of an individual to perform sequential and directional movements by rapidly initiating and terminating the movement of the three major articulator components as lips, tongue tip and/or dorsum of the tongue.[21,22] One of the methods used in the research for the oral-DDK rate calculation is the "count-by-time" method in which the repetitions produced within a certain time period (e.g., 5 or 10 seconds) are counted.[23-26] The other one is the "time-by-count" method where the time taken for a certain number of repetitions is calculated.[27-30]

It is seen that most of the studies that evaluate the speech motor skill in stuttering by oral-DDK rate measurement are conducted with pediatric groups.[20,31] There is some evidence that children with stuttering have lower oral-DDK performances than those without stuttering.[32] This performance also differentiates according to syllable structure in PWS.[33] For example, Çiyiltepe and Çifçi compared the diadochokinetic skills of children who stutter (CWS) (n=17) and their fluent peers (CWNS) (n=19) ranging in age from 7 and 12.[34] CWNS performed significantly faster in /pa/ and /ka/ syllables than CWS. Juste et al. found that the significant difference in the oral-DDK performance of children with and without stuttering was between age groups rather than the presence or absence of stuttering.[20] They concluded that this difference was not related to stuttering itself but speech-connected motor development age. Yaruss et al. found a negative correlation between speaking rate and oral-DDK rate in children with stuttering.[31] On this subject, researchers commented that children with stuttering might have tried to use speech rate at a level that exceeds their ability to perform articulation fast and clearly.[3] Concordantly, motor stabilization decreases while performing complex speech tasks.[35,36] Improvements in speech motor skills in stuttering therapies may also lead to some changes in the stuttering severity.[37] In this respect, there are also studies dealing with the relationship between speech motor skills and psychological processes such as emotional activity, cognitive stress, or anxiety.[38-40] However, the findings on the direct relationship of social anxiety related to speech motor skills and stuttering are controversial.

It is seen that the pieces of research evidence examining the psychological aspects of stuttering are controversial. In this respect, although it is difficult to argue that there is a valid trait or psychopathology for all PWS, some characteristics appear to be prominent.[38,41,42] There have been remarkable findings obtained about some psychological qualities such as temperament, emotional reactivity, and the tendency to learn.[43-45] These factors are included in the current models. According to these models, it is accepted that psychological factors play a role in a complex interaction with other factors such as the onset, course, and symptoms of stuttering.[2,7,46,47] The interaction of psychological qualities with various factors such as environment and biology may have a decisive role in the formation of secondary behaviours.[42]

Many authors have shown the effect of some psychological factors, especially anxiety, on stuttering severity.[19,48-51] Therefore, the view that reducing anxiety is an important goal in therapies is supported.[52] In this context, they also mentioned the need

for new researches about the relationship between stuttering severity and anxiety.[53]

THE CURRENT STUDY

In the literature, it is seen that the studies on the severity of stuttering and the studies that include the multiple comparisons of secondary behaviours and motoric and psychological variables provide a more comprehensive view of stuttering. When we look at the studies evaluating oral-DDK skills in PWS, it is seen that these studies are mostly carried out in the child population. Other studies, on the other hand, are based on comparisons between stuttering and non-stuttering individuals without considering other factors about stuttering.[20,24,32] However, there are also studies examining the relationship between motor skills and some variables, such as the articulation rate, albeit no oral-DDK rate measurement.[44] Similarly, studies examining the association of stuttering with psychological factors such as anxiety often do not include multidimensional assessments.[38,54,55]

The main aim of this study, which includes descriptive correlational design, is to investigate the relationships between variables in four categories. These variables are a) stuttering variables (SS% in speech and reading, duration, secondary behaviors), b) physical tension, c) oral-DDK rate, and d) Unhelpful Thoughts and Beliefs about Stuttering-Turkish Version (UTBAS-TR) total and sub-scale scores. The following research questions were raised:

1. Is there any relation between all stuttering variables?

2. Is there any relation between stuttering variables and UTBAS-TR scores?

3. Is there any relation between stuttering variables and oral-DDK rates?

4. Is there any relation between oral-DDK rates and UTBAS-TR scores?

5. Does any variable(s) has a predictable effect on secondary behaviors?

A number of hypotheses have been determined for the purpose of the present study in the light of stuttering literature. Firstly, we hypothesized that there are various levels of relationships between stuttering variables (SS% scores, duration, and secondary behaviors) since stuttering is a phenomenon in which related components coexist.[56,57]

Some authors have suggested that stuttering has a multifactorial nature.[7,46,47] Therefore, as the second hypothesis of this study, it was predicted that stuttering variables were not likely to show high relationships with the oral-DDK rate in this study because there is a very complex relationship between these two variables.

When we address the complex nature of stuttering, and extensive literature covers the speech motor skills and anxiety in stuttering.[39,44] Then, as the third hypothesis of the study, we predicted that there is some relationship between oral-DDK and UTBAS-TR scores.

The last hypothesis is that SS%, duration, physical tension, and UTBAS-TR scores are predictors of the secondary behavior scores. Because when PWSs are considered as a group, it is expected that stuttering variables, especially duration of disfluencies, will increase compatibly with secondary behaviors (vice versa). Also, considering the model proposed by Brutten and Shoemaker, secondary behaviors will increase as unhelpful thoughts about the stuttering increase.[58]

MATERIAL AND METHODS

PARTICIPANTS

The participants consisted of four females (14.3%) and 24 males (85.7%). The age of the participants ranged between 18-56 (M=29.4±8.45). Participants who had responded positively to the advert shared in several speech and language pathology (SLP) centers, Turkish Stutterers Association, and SLP professional e-mail groups. All participants a) were diagnosed with stuttering by the second author, have over SS 2% in the spontaneous speech, and b) have no neurological, mental, or developmental disorders.

MATERIALS AND PROCEDURE

Data were collected at the therapy rooms in Üsküdar University's Polyclinic and private SLP clinics. The participants were asked to sit across from the re-

searcher. Participants were informed about the content of the study and given the informed consent form for whether they were willing to participate. After obtaining the consent of the participants, they were asked to fill out their demographic information (name, surname, gender, date of birth, age) by providing them with a personal information form prepared by the researchers. Data on stuttering variables [Stuttering Severity Instrument-4 (SSI-4) and physical tension scores], oral-DDK scores, and UTBAS-TR scores were obtained from the participants. After receiving spontaneous speech and reading samples, the oral-DDK rate was measured, and the participants were asked to fill in UTBAS-TR. The entire data collection process was completed in a single session of about thirty minutes.

Stuttering Variables

To measures the stuttering behaviours (frequency, duration, secondary behaviour) and physical tension, a 400-syllable spontaneous speech sample was taken from the participants.[42] A spontaneous speech sample was carried out by the researcher asking open-ended questions to the participant. The selected topics were chosen concerning the school, profession, or field of interest of participants. Then, a reading sample was taken with a video recording, having the participants read a phonetically balanced text comprised of 400 syllables. The speech and reading samples were recorded on the iPhone 6s A1688 mobile phone.

Stuttering severity

Participants' stuttering severity levels were examined based on SSI-4 procedure, which was previously used by the researchers and is still prevalently used in the field.[56] However, since the SSI-4 did not have Turkish adaptation of the age range of the participant group, these data were used as a raw score. This preference was considered a limitation. In this direction, SS%, duration, and secondary behaviours of the participants were assessed.

Frequency

The video recordings of 400-syllable spontaneous speech and reading samples obtained from the participants were transferred into the electronic environment. The total number of stuttered syllables was determined from the video recordings, and the number of stuttered syllables were divided by the total number of syllables and multiplied by 100 to separately calculate the SS% data of the participants' spontaneous speech and reading.[42]

Duration

Spontaneous speech samples of the participants were transferred to the video environment. Each participant's at least three moments of disfluency were determined using a chronometer. Subsequently, these three moments of disfluency were averaged as a duration value (sec).

Secondary Behaviours

To measure the symptoms of secondary behaviour, three SLP bachelor's degree senior year students watched the video recordings of the participants on the computer environment. Raters evaluated each participant in terms of the four parameters (annoying sounds, facial tensions, head movements, extremity movements) included in SSI-4 protocol with a 5-point Likert scale and as independent of each other. After taking the mean of three scores obtained from the raters, the secondary behaviour score was determined for each participant and used as a raw score.

Physical tension

In this study, a perceptual assessment procedure for physical tension was used in accordance with the literature.[59] The physical tension levels of the participants were also evaluated by three SLP senior students using a 9-point Likert type scale developed by the researchers. There are studies in which the tensions in adults who stutter (AWS) are perceptually evaluated, and their reliability is discussed.[10,60] The instruction was provided for the raters. According to these instructions, they were asked to evaluate the tensions in the larynx, jaw, tongue, lip recognized in participants' faces, and the abnormal tensions of the muscles in other parts of their body.[10,61] Evaluators scored the physical tensions independently of each other by watching the spontaneous speech video recordings of the participants (1-minimum tension, 9-maximum tension). The means of the scores obtained from three evaluators were taken for each participant.

Oral-Diadochokinetic Rate

Oral-diadochokinetic rate task

For the oral-DDK rate assessment, participants were asked to repeat monosyllabic, disyllabic, and trisyllabic oral-DDK tasks. Oral-DDK syllable repetitions were recorded from a 15 cm distance to the mouth and using the SONY ICD-UX533 voice recording device held at a 45-degree angle. "Count-by-time" method was used for oral-DDK rate measurement.[23-26,62,63] During the use of this method data, including participants' 10-sec clear utterances, were examined.

Oral-DDK measurement is of seven stages as follows: /pa/, /ta/, /ka/, /pata/, /paka/, /taka/ and /pataka/ The participants were asked to produce these tasks as fast and as accurately as possible and to continue to repeat until the researcher says "Stop". The instructions given to the participants are as follows:

"I will ask you to repeat a series of meaningless syllables. These are /pa/, /ta/ and /ka/ syllables. We will start with /pa/ syllable. Take a deep breath before you start and produce this syllable consecutively as many times as you can for about 10 seconds. When uttering these syllables fast, you should make sure that they are clear and understandable. Carry on doing this until I say 'Stop'. Now I will give you an example and then you will try. Then I will start recording."

In cases where participants ran out of breath, they were given the following instruction: "*If you run out of breath, you may breathe again and continue*". Likewise, since there was an attempt to increase the speed noticeably, it was re-recorded in cases where clear production of syllables could not be attained, and it was reported to the participants that the syllables should be produced clearly and understandably.

In order not to include participants' pauses unrelated to speech (e.g., breathing, stuttering-like disfluencies, normal disfluencies) in the 10-second voice recording, the duration of the block and breathing pauses were followed and voice recordings longer than 10 seconds were taken.

Oral-Diadochokinetic *Rate Measurement*

After taking voice recordings of participants' oral-DDK syllable repetition, seven voice recordings obtained from each participant were transferred into a MacBook Air A1466 model laptop computer. Audio recordings were analyzed with ©PRAAT 6.0.37 acoustic analysis program at 44.1 kHz and 16-bit sampling rate.[64] Syllable produce in the voice recordings were manually counted by the researcher through the visual and auditory information obtained from the waveform. Figure 1 presents the representation of the analysis performed on the PRAAT program. In the first grey part, /papa/ utterance includes one syllable repetition followed by one block of /pppp/, another syllable repetition with /papa/ and a block and silence with /ppp/. In the second gray part, a pause of 930 ms occurred. Both colored parts were

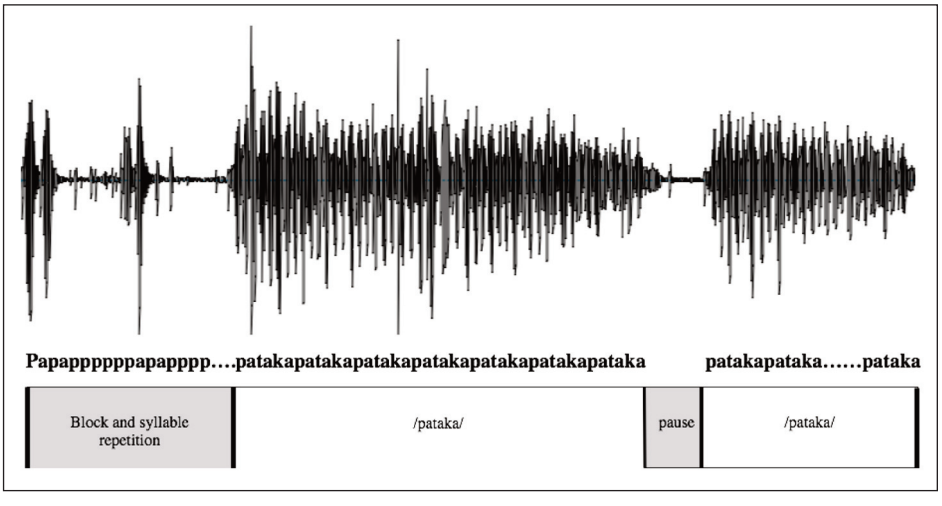

FIGURE 1: Representation of the analysis performed on the PRAAT program.

excluded from the analysis and not included in the total duration.

In the PRAAT program, in the analysis stage, unrelated pauses (breathing, blocks, etc.) exceeding 250 ms are excluded from the recording in accordance with the literature.[44,65-67] Also, improperly produced syllables were excluded from the recording (e.g., /pıtıka/ or /pakaka/ instead of /pataka/). In the absence of participants' pauses unrelated to speech and disfluencies related to stuttering, the syllable productions were calculated over a recording of precisely 10 seconds, which was obtained by cutting the recording from the beginning and end in equal durations. Oral-DDK rates were calculated through the division of the sum of all syllables produced for each voice recording file by the total duration.[26]

Unhelpful Thoughts and Beliefs About Stuttering-Turkish Version Scales

The UTBAS was used to measure negative thoughts, beliefs, and anxiety about stuttering in participants.[68] Aydın, Ege examined the validity and reliability of the Turkish version of UTBAS in 100 Turkish adults, 81 males (81%,) 19 females (19%), with ages ranging from 17 to 41 years (M=23.5; SD=3.5).[69]

The UTBAS includes 66 items and is based on a 5-point Likert design. The scale has three subscales. The scale consists of three subscales: UTBAS-TR-I (feelings), UTBAS-TR-II (beliefs), and UTBAS-TR-III (anxiety). The scale provides separate scores for all three sets of responses as well as a total score, which is the sum of all these three (UTBAS-TR-Total). Higher scores indicate higher negative thoughts, beliefs, and anxiety about stuttering.[69,70]

In this adaptation study, the authors obtained psychometric properties compatible with the original version. The internal consistency of the scale was found to be high between 0.94 and 0.97. The correlations between total score and three subscales were found to be high as UTBAS-TR-I=0.98, UTBAS-TR-II=0.99, and UTBAS-TR-III=0.99. They found a significant correlation between UTBAS-TR total score and the State Anxiety Inventory (p=0.34). Nevertheless, they found low correlations between the UTBAS-TR total score with the Trait Anxiety Inventory (p=-0.16) and the Beck Anxiety Inventory (p=0.19).

In this study, the participants were asked to carefully read each item in the UTBAS-TR test and then assign a relevance score for each of the three sections that evaluate frequency, belief, and anxiety. It took approximately fifteen minutes to complete the UTBAS-TR scale of the participants.

MEASUREMENT RELIABILITY

Inter-rater reliability analysis was used to evaluate the reliability of physical tension measurement. Three independent raters who scored the participants independently of each other were found to be in very high-level agreement with each other (Cronbach's α=0.95).

STATISTICAL ANALYSIS

For statistical analysis of the data obtained from the participants, SPSS version 20 (Statistical Package for the Social Sciences) was used. The descriptive data on all variables related to the stuttering obtained in this study were calculated. Pearson correlation analysis was used to investigate the relationship between these variables. Furthermore, multivariable regression analysis was performed to determine these variables' prediction degrees of secondary behaviours. The statistical significance value was considered $p \leq 0.05$.

ETHICAL CONSIDERATIONS

Approval from Üsküdar University Ethics Committee (date: 29.01.2020, number: 61351342/2020-71) and written informed consent from all participants were obtained. The study was conducted in accordance with the principles of the Declaration of Helsinki.

RESULTS

RELATIONSHIPS BETWEEN SS% IN SPEECH AND READING, DURATION, SECONDARY BEHAVIOURS, AND PHYSICAL TENSION

Table 1 presents the descriptive statistics and the results of a correlation analysis of the stuttering variables (SS%, duration, secondary behaviour, physical

TABLE 1: Correlations between SS% in speech and reading, duration, secondary behaviours, physical tension.

			Stuttering variables				
			Speech SS%	Reading SS%	Duration (second)	Secondary behaviours	Physical tension
Stuttering variables	M	SD	r/p value	r/p value	r/p value	r/p value	r/p value
Speech SS%	6.9	6.23	1				
Reading SS%	5.6	6.72	0.821/<0.001**	1			
Duration (second)	2.9	2.59	0.377/0.048*	0.451/0.016*	1		
Secondary behaviours	3.4	2.37	0.542/0.003*	0.506/0.006*	0.387/0.042*	1	
Physical tension	2.4	1.41	0.515/0.005*	0.451/0.016*	0.250/0.199	0.855/<0.001**	1

*p<0.05; **p<0.001; M: Means; SD: Standard deviation; SS: Sum of squares.

TABLE 2: Correlations between monosyllable (/pa/, /ta/, /ka/), bisyllable (/pata/, /paka/, /taka/), trisyllable (/pataka/) oral-diadochokinetic rates.

			/pa/	/ta/	/ka/	/pata/	/paka/	/taka/	
Oral-diadochokinetic rates	M	SD	r/p value	r/p value	r/p value	r/p value	r/p value	r/p value	/pataka/
/pa/	6.0	0.81	1						
/ta/	5.9	1.03	0.760/<0.001**	1					
/ka/	5.5	4.10	0.660/<0.001**	0.773/0.027*	1				
/pata/	6.9	4.80	0.492/0.008*	0.484/0.009*	0.376/0.049*	1			
/paka/	6.2	0.90	0.440/ 0.019*	0.531/0.004*	0.441/0.019*	0.747/<0.001**	1		
/taka/	6.5	0.77	0.532/0.004*	0.476/0.011*	0.406/0.032*	0.676/<0.001**	0.756/<0.001**	1	
/pataka/	6.5	0.75	0.418/0.027*	0.375/0.049*	0.315/0.103	0.450/0.016*	0.569/0.002*	0.63/<0.001**	1

*p<0.05; **p<0.001; M: Means; SD: Standard deviation.

tension in connected-speech, and SS% in reading) obtained from the study group.

When the correlation analysis findings among the stuttering variables were examined, a correlation was found among all variables except physical tension and duration (Table 1). It is seen that the strongest relationship was between secondary behaviour and physical tension (r=0.85, p<0.05). The other variables in which the physical tension demonstrated a positive correlation were SS% in speech (r=0.54, p<0.05) and reading (r=0.50, p<0.05). In addition, another strong correlation is observed between speech SS% and reading SS% (r=0.82, p<0.05). Speech SS% scores weakest correlation was found to be with the variable of duration (r=0.37, p<0.05). When the correlations between secondary behaviours and other variables were examined, it was found that SS% showed a moderate correlation with speech (r=0.54, p<0.05) and reading (r=0.50, p<0.05), and demonstrated a weak correlation with the duration variable (r=0.38, p<0.05).

RELATIONSHIPS BETWEEN MONOSYLLABLE (/pa/, /ta/, /ka/), bisyllable /pata/, /paka/, /taka/) AND TRISYLLABLE (/pataka/) ORAL-DIADOCHOKINETIC RATES

Descriptive statistics on the oral-DDK performance of the study group were calculated. Additionally, the

TABLE 3: Correlations between stuttering variables and oral-diadochokinetic rates.

	Stuttering variables				
	Speech SS%	Reading SS%	Duration (second)	Secondary behaviours	Physical tension
Oral-diadochokinetic rates	r/p value	r/p value	r/p value	r/p value	r/p value
/pa/	-0.052/0.794	-0.281/0.148	-0.163/0.408	0.153/0.438	0.093/0.638
/ta/	0.128/0.518	-0.010/0.961	-0.070/0.724	0.164/0.404	0.198/0.312
/ka/	-0.159/0.419	-0.206/0.292	-0.012/0.953	0.079/0.689	0.096/0.626
/pata/	-0.039/0.842	-0.115/0.560	0.019/0.924	0.025/0.899	-0.158/0.423
/paka/	0.079/0.689	0.016/0.935	-0.043/0.830	0.183/0.352	0.031/0.875
/taka/	0.078/0.694	-0.084/0.670	0.009/0.964	0.296/0.127	0.177/0.367
/pataka/	-0.110/0.578	-0.265/0.173	-0.352/0.066	-0.121/0.540	-0.051/0.797

SS: Sum of squares.

correlations of these variables are presented in Table 2.

When Table 2 is examined, it is seen that there are significant positive correlations between all the other functions except for the correlation of the /pataka/ and /ka/ syllables. However, as the number of syllables increases, the correlation strength decreases. Monosyllable oral-DDK produce are highly correlated among themselves, and similarly, the two-syllable oral-DDK productions are highly correlated with one another. Nevertheless, monosyllabic production had a significant moderate correlation with disyllabic oral-DDK production and weak correlation with trisyllabic oral-DDK production. For example, while /ta/ syllable's oral-DDK rate showed a high positive correlation ($r=0.77$, $p<0.05$) with the oral-DDK rate of /ka/ syllable, /pata/ syllable's oral-DDK rate had a moderate correlation ($r=0.48$, $p<0.05$) with the oral-DDK rate of /pataka/ syllable ($r=0.37$, $p<0.05$).

RELATIONSHIPS BETWEEN STUTTERING VARIABLES AND ORAL-DIADOCHOKINETIC RATES

Table 3 shows the correlations between the performances in the oral-DDK measurement and the stuttering variables (SS% in speech and reading), duration, secondary behaviour, physical tension) obtained from the oral reading and connected speech task of the participant group.

There was no significant relationship between all stuttering variables of the study group and all oral-DDK tasks (Table 3). Similarly, when the /pa/, /ta/ and /ka/ oral-DDK performances of the participants were considered together as "monosyllabic oral-DDK", there was no significant relationship between this variable and stuttering variables.

RELATIONSHIPS BETWEEN UNHELPFUL THOUGHTS AND BELIEFS ABOUT STUTTERING-TURKISH VERSION TOTAL AND SUBSCALES SCORES

Descriptive statistics for UTBAS-TR total and subscale scores of the study group were calculated. Also,

TABLE 4: Correlations between UTBAS-TR-I, UTBAS-TR-II, UTBAS-TR-III, and UTBAS-TR total scores.

			UTBAS-TR			
			UTBAS-TR-I (Frequency)	UTBAS-TR-II (Beliefs)	UTBAS-TR-III (Anxiety)	UTBAS-TR Total
UTBAS-TR	M	SD	r/p value	r/p value	r/p value	r/p value
UTBAS-TR-I (Frequency)	129.7	38.3	1			
UTBAS-TR-II (Beliefs)	125.7	40.9	0.901/<0.001**	1		
UTBAS-TR-III (Anxiety)	134.1	50.0	0.890/<0.001**	0.936/<0.001**	1	
UTBAS-TR Total	389.5	125.4	0.955/<0.001**	0.975/<0.001**	0.977/<0.001**	1

*p<0.05; **p<0.001; UTBAS-TR: Unhelpful thoughts and beliefs about stuttering-Turkish version; M: Means; SD: Standard deviation.

TABLE 5: Correlations Between Stuttering Variables and UTBAS-TR Scores.

	Stuttering variables				
	Speech SS%	Reading SS%	Duration (second)	Secondary behaviours	Physical tension
UTBAS-TR	r/p value	r/p value	r/p value	r/p value	r/p value
UTBAS-TR-I (Frequency)	0.313/0.105	0.135/0.494	0.502/0.007*	0.156/0.427	0.197/0.315
UTBAS -TR-II (Beliefs)	0.249/0.249	0.137/0.485	0.579/0.001*	0.177/0.366	0.240/0.220
UTBAS-TR-III (Anxiety)	0.405/0.033*	0.293/0.131	0.512/0.005*	0.258/0.185	0.323/0.094
UTBAS-TR Total	0.338/0.078	0.203/0.301	0.547/0.003*	0.209/0.287	0.267/0.169

TABLE 6: Correlations between Oral-DDK rates and UTBAS-TR scores.

	Oral-DDK rates						
	/pa/	/ta/	/ka/	/pata/	/paka/	/taka/	/pataka/
UTBAS-TR	r/p value	r/p value	r/p value	r/p value	r/p value	r/p value	r/p value
UTBAS-TR (Frequency)	-0.021/0.916	-0.119/0.548	0.032/0.873	-0.314/0.103	-0.343/0.074	-0.167/0.395	-0.142/0.470
UTBAS-TR-II (Beliefs)	-0.144/0.465	-0.182/0.355	-0.061/0.757	-0.263/0.177	-0.375/0.049*	-0.134/0.498	-0.201/0.304
UTBAS-TR-III (Anxiety)	-0.161/0.413	-0.195/0.320	-0.165/0.400	-0.384/0.044*	-0.415/0.028*	-0.208/0.288	-0.259/0.184
UTBAS-TR Total	-0.118/0.551	-0.173/0.378	-0.076/0.700	-0.335/0.081	-0.393/0.039*	0.178/0.366	-0.213/0.278

*p<0.05; Oral-DDK: Oral-diadochokinetic; UTBAS-TR: Unhelpful thoughts and beliefs about stuttering-Turkish version.

these variables' correlation with one another is presented in Table 4.

Table 4 presents that each of the UTBAS-TR subscales demonstrates significant positive correlations with each other and with the UTBAS-TR total score. Based on these findings, it can be stated that the scale is in integrity.

RELATIONSHIPS BETWEEN STUTTERING VARIABLES AND UNHELPFUL THOUGHTS AND BELIEFS ABOUT STUTTERING-TURKISH VERSION TOTAL AND SUBSCALES SCORES

Table 5 presents the correlation analysis findings between UTBAS-TR total and its subscale scores (frequency, beliefs, and anxiety) and stuttering variables (SS% in speech and reading, duration, secondary behaviours, and physical tension).

As seen in Table 5, SS% in speech demonstrated a positive correlation with only UTBAS-TR-III (anxiety) score (r=0.40, p<0.05). The duration variable showed a positive correlation with UTBAS-TR total score (r=0.54, p<0.05), UTBAS-TR-I (r=0.50, p<0.05), UTBAS-TR-II (r=0.57, p<0.05) and UTBAS-TR-III (r=0.51, p<0.05) subscales. Reading SS%, secondary behaviours, and physical tension variables did not show a significant relationship with any of the UTBAS-TR score.

RELATIONSHIPS BETWEEN ORAL-DIADOCHOKINETIC RATES AND UNHELPFUL THOUGHTS AND BELIEFS ABOUT STUTTERING-TURKISH VERSION SCORES

Table 6 shows the correlation analysis between all performances of the study group in oral-DDK tasks and UTBAS-TR total and subscale scores (frequency, beliefs, and anxiety).

In Table 6, it is seen that there are four significant negative relationships between oral-DDK rates and UTBAS-TR scores. Examining the relationship between the oral-DDK rates and UTBAS-TR test scores, oral-DDK rate of /pata/ syllable and UTBAS-TR-III (anxiety) score was found to have a weak negative correlation (r=-0.38, p<0.05). It is seen that /paka/ syllable had a weak negative correlation with UTBAS-TR-II (Beliefs) (r=-0.37, p<0.05) and UTBAS-TR total (r=-0.39, p<0.05) scores, and had a

TABLE 7: Results of the participants' other evaluation scores according to secondary behaviour scores. (regression results using secondary behaviours as the criterion).

Model	SS	SD	MS	F	p value
Regression	131.19	14	9.37	5.89	0.001*
Excesses	20.65	13	1.58		
Total	151.85	27			

*p<0.05; SS: Sum of squares; SD: Standard deviation; MS; Mean square.

TABLE 8: Coefficients and significance levels of the independent variables which are examined on their effect on participants' secondary behaviour scores.

	Coefficients			Confidence interval (95.0%)	
Model	B	SE	p value	Lower Limit	Upper Limit
Constant	-2.505	3.291	0.460	-9.615	4.604
Speech SS%	-0.014	0.098	0.886	-0.226	0.197
Reading SS%	0.051	0.088	0.569	-0.138	0.240
Duration (second)	0.111	0.166	0.513	-0.247	0.469
Oral-DDK /pa/	0.702	0.633	0.288	-0.666	2.070
Oral-DDK /ta/	-0.592	0.571	0.319	-1.825	0.641
Oral-DDK /ka/	-0.054	0.680	0.937	-1.524	1.415
Oral-DDK /pata/	0.138	0.539	0.802	-1.026	1.302
Oral-DDK /paka/	0.376	0.585	0.532	-0.889	1.640
Oral-DDK /taka/	0.564	0.656	0.406	-0.854	1.981
Oral-DDK /pataka/	-0.736	0.527	0.186	-1.874	0.403
UTBAS-TR-I (Frequency)	0.007	0.022	0.753	-0.040	0.054
UTBAS-TR-II (Beliefs)	-0.013	0.028	0.646	-0.074	0.048
UTBAS-TR-III (Anxiety)	0.003	0.022	0.877	-0.044	0.050
Physical tension	1.301	0.242	<0.001**	0.777	1.825

**p < 0.001; SS: Sum of squares; Oral-DDK: Oral-diadochokinetic; UTBAS-TR: Unhelpful thoughts and beliefs about stuttering-Turkish version.

moderate negative correlation with UTBAS-TR III (Anxiety) (r=-0.41, p<0.05) scores. However, when the /pata/, /paka/ and /taka/ oral-DDK performances of participants were considered together as "bisyllable oral-DDK", this variable was observed to have a moderate negative relationship only with UTBAS-TR anxiety subtest (r=-0.38, p=0.05).

IDENTIFY THE VARIABLE(S) PREDICTING SECONDARY BEHAVIOURS

In this study, whether this model was significant was examined by ANOVA regression analysis before the regression analysis to identify the variable(s) predicting the secondary behaviours (Table 7).

According to Table 7, as a result of the regression analysis in which secondary behaviour scores are evaluated as dependent variables and other evaluation scores considered as the independent variable were examined, the model was found to be a significant (p<0.001). In Table 8, the individual coefficients and significance levels of the parameters included in the model determined to be significant are presented.

When Table 8 was examined, it was determined that only the 'physical tension' parameter (p<0.001) was significant for the variables that were evaluated for whether or not they predict secondary behaviours. Thus, it can be concluded that a one-unit increase in physical tension score results in an increase of 1.301 units in secondary behaviour scores.

DISCUSSION

The current study examined the relationship between stuttering behaviours (frequency, duration, secondary behaviours), physical tension, oral-DDK rates, and the UTBAS-TR subscales and total scores with 28 AWS.

One of the crucial findings of this study is the significant positive correlation between stuttering severity variables (SS% in speech and reading and duration) and secondary behaviours. Accordingly, in the participant group, the SS%, and duration in speech increases in line with an increase in secondary behaviours (vice versa). Other findings in this light are the significant positive relationship between SS% in speech and reading and physical tension. Similarly, Shapiro who investigated the severity of stuttering and laryngeal muscle activation, found that the degree of contraction and length of a given muscle may be proportional to the degree and duration of a given block.[14] However, in Shapiro's research, no significant correlation was found between duration and physical tension.[14] It is thought that the reason for the differing results in terms of duration may have been due to the evaluation of tension and muscle activation employing different methods in both studies.

Considering the phenomenon of stuttering and age range of the participant group (advanced stuttering), the relationships among the stuttering severity variables (SS% in speech and reading, duration), physical tension and secondary behaviour are expected results.[1,42,46] Prolonged disfluencies in PWS that is an individual's inability to overcome disfluencies at ease in a short time may lead to the emergence of secondary behaviours and tension.[3] However, although secondary behaviours are widely accepted as behaviours used to flee or avoid core behaviours, they have a very complex mechanism.[1] In this respect, the presence of mediating factors should not be overlooked. For instance, variables such as temperament, attitude, susceptibility to learning, physiological factors and environment may play a decisive role in these reactions.[42] Also, previous experience of therapy is of significance. For instance, PWS who benefit from the approaches that dwell on attention, sensitivity, and attitudes towards disfluencies or try to cope with the moments of disfluencies, may exhibit secondary behaviours less frequently although their severity of stuttering could be high. In larger samples, the studies to be carried out taking into account the variables as mentioned above will reveal the underlying mechanism of secondary behaviours.

A quality that is evaluated within the probable multidimensional mechanism of secondary behaviour is physical tension.[59] However, it is stated that SSI-4's physical concomitants subscale does not adequately encompass the body locations where PWS experience tension.[10,56] Therefore, the perceptual tension, from the viewpoint of raters, was examined as a variable external to SSI-4.[56] This method of evaluation, also used by previous researchers may not be a reliable way.[10] To augment the validity of the evaluation, evaluations by objective tools specific to moments of stuttering and perceptual evaluations of participants can be used.[10,71]

In this study, a significant finding stands to be the presence of a significant positive relationship between physical tension and secondary behaviours, despite the limitation to the evaluation of the aforementioned physical tension. Additionally, physical tension predicts secondary behaviours. In other words, the increase or decrease in the physical tension perceived by the raters in parallel with the secondary behaviours defined in SSI-4. This causal relationship also demonstrates that there is a need for physical tension for the emergence of secondary behaviours. Many authors have also mentioned this relationship.[42] Physical tension occurs in an effort to maintain fluency or escape from the moment of stuttering, similar to secondary behaviours. It is also seen as a reaction to anticipation or learning.[10] On the other hand, many studies examine the subject and underlying causes from a more physiological viewpoint such as the limbic system, especially the increased activation of the amygdala, and the anxious arousal.[51] Given the findings of the authors or the proposed models or opinions, it is thought that physical tension, which is part of the stuttering phenomenon, should be evaluated independently of SSI-4, which would prove more functional. Thus, it will be more likely to identify better the stuttering experiences which are unique and dynamic for each person.

Another finding of our study is the examination of the relationship between UTBAS-TR total score and sub-scores (frequency, beliefs, and anxiety). Iverach et al. in support of this, found that each subscale test showed a significantly strong correlation with

one another.[70] The goodness-of-fit between the subscales support the findings presented by Aydın, Ege who carried out the adaptation of the Turkish version of UTBAS.[69]

In this study, the duration variable in stuttering showed a significant positive correlation with UTBAS-TR total score and all sub-test scores (frequency, beliefs, and anxiety). SS% scores in connected speech task demonstrated a significant positive correlation with UTBAS-TR-II (anxiety) score. In the light of these findings, when the AWS is considered as a group, it can be interpreted that, with the increase in severity pertaining to the core behaviour of stuttering, these individuals are more vulnerable to negative thoughts, beliefs, and anxiety. Doubtless, as mentioned above, this relationship may be lower in patients who receive therapy according to all therapeutic needs, not merely to reduce stuttering symptoms. This association is because the relationship between stuttering and anxiety involves a complex pattern involving various variables.[55]

In this study, the relationship between the duration variable and the frequency of spontaneous speech, similar to other studies in the field, and the UTBAS-TR anxiety score, suggest that increased social anxiety in chronic stuttering may similarly lead to an increase in stuttering severity.[11,49] However, in arguing that emotional factors cause a change in the severity of stuttering, it is more reasonable to consider emotions as a modulating factor that affects motor stability, not as a factor that causes stuttering.[72] Although the severity of stuttering is a crucial clue for anxiety in the light of the findings and similar studies, it would be more accurate to consider multiple factors when evaluating stuttering anxiety.[73]

Additionally, another important finding in this study was that UTBAS-TR anxiety subscale scores demonstrated a negative relationship with /pata/ and /paka/ oral-DDK rates. In other words, the increase in the anxiety about speech and the deterioration of oral-DDK performances are parallel with one another (or vice versa). There is ample evidence that speech production and emotional processing are in interaction with each other. In this respect, Hennessey Dourado, Beilby argued that in PWS, speech is associated with the motor system.[39] However in previous studies, it is seen that there are different findings or opinions about this relationship. This controversy may be due to the use of different measurement tools or evaluation methods in such studies.[4,38,74] In the multifactorial models trying to explain stuttering, it is emphasized that many factors such as language, cognition, motor, auditory processing, psychology and environment exhibit complex interaction in stuttering.[7,46] At this point, moreover, studies which are aimed at identifying the subtypes in stuttering also shed light on the multi-dimensional structure of stuttering.[4]

There were seven tasks used in the evaluation of participants' oral-DDK rate. Considering the relationships between these tasks, significant correlations were obtained in all of them at various degrees except one (/ka/ and /pataka/). Monosyllable tasks and the disyllable tasks had significantly higher correlations among themselves. In contrast, monosyllable tasks and dissyllable tasks demonstrated lower correlations with each other. /pataka/ task, however, showed the lowest correlations relative to other tasks. Two conclusions can be drawn about these findings. First, the performance of the tasks varies as the oral-DDK rate assessment of the number of syllables and phonetic diversity increases. Put differently, /pataka/ task includes a more complex motor demand than /ka/ task. Therefore, in accordance with previous researches, participants did not perform as fast as in monosyllable tasks.[35,36] Kleinow & Smith accordingly, concluded that motor stability decreased when utterances demanded to be produced in AWS become more complex.[36] Demanding non-word syllable repetition with oral-DDK evaluation leads to neuromotor demands for a new motor programming before linguistic competence.[33] In this respect, these findings are not unexpected given the fact that PWS as a group in the literature shows poor performances related to these tasks. The second inferences to be made from all correlations is that it would prove more useful to use all possible oral-DDK syllable tasks in oral-DDK rate evaluation in clinics or studies. Thus, more comprehensive knowledge will be provided to clinicians and researchers as the case's speech motor ability will be evaluated with tasks at various difficulty levels.

CONCLUSION

In this study, the relationships among a) SS% data, duration, secondary behaviours b) physical tension, c) oral-DDK rate and d) all UTBAS-TR scores were examined in AWS. Taking an overall look at the study findings, various positive or negative correlations were found among these four categories. Also, the relationships between variables were found among the categories which included multiple components such as stuttering data. These findings support the multidimensional structure of stuttering and the view that each component may be associated with others at various levels. The significance of a more thorough investigation of the relationships that are found significant between variables in the discovery of primarily this phenomenon is obvious.

When the findings obtained are examined in detail, it is seen that secondary behaviours and physical tension increase as the stuttering severity increases in AWS as a group (or vice versa). It is also seen that physical tension has a crucial effect on the emergence of secondary behaviours. As a predictable finding, although there is no causal relationship, social anxiety increases in line with the severity of stuttering (or vice versa). There is also a relationship between motor skill (oral-DDK) and social anxiety, which may seem to be unrelated from the outside. Lastly, the findings obtained from the oral-DDK rate correlation evaluating speech motor skills supported the opinions that speech motor performance was impaired with the increase in syllable complexity demanded from AWS.

Correlations exhibited by the symptoms pertinent to stuttering and the fact that the tension predicts secondary behaviours indicate that the findings also provide important implications for the clinical field. Knowing the relationships between these variables related to stuttering will give clinicians an idea about which variable should be controlled first during stuttering therapies (e.g., studies towards the reduction of the physical tension during therapy may have a positive effect on secondary behaviours). In this respect, it is thought that the multidimensional approach will be more beneficial in the evaluation and therapy of stuttering.

LIMITATIONS AND FUTURE DIRECTIONS

In this study, the use of SSI-4, which has no adaptation to Turkish in the adult population, can be considered as a limitation. In this decision, researchers' willingness to make a more holistic evaluation was decisive. Therefore, although SSI-4 protocol was used for the evaluation of secondary behaviours, the scores were examined as raw points. Another limitation of the study was the lack of consideration of whether participants had received therapy or not. It is thought that this situation may have affected the scores of the participants on the UTBAS-TR scale or their stuttering severity. In future studies, cognitions can be examined more easily with UTBAS short version (see for UTBAS-6).[75] In addition to cognitions, anxiety can also be used in the evaluation of physiological measurements. Physical tension can be measured objectively with EMG or with the perceptual feedbacks in PWS. Furthermore, multidimensional data obtained through these measurement techniques in large samples can be analyzed by structural equation modeling. Thus, the interaction of these variables can be seen in a single table.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Mehmet Emrah Cangi, Ayşe Işıldar;* ***Design:*** *Mehmet Emrah Cangi;* ***Control/Supervision:*** *Mehmet Emrah Cangi;* ***Data Collection and/or Processing:*** *Ayşe Işıldar;* ***Analysis and/or Interpretation:*** *Mehmet Emrah Cangi, Ayşe Işıldar;* ***Literature Review:*** *Mehmet Emrah Cangi, Ayşe Işıldar;* ***Writing the Article:*** *Mehmet Emrah Cangi, Ayşe Işıldar;* ***Critical Review:*** *Mehmet Emrah Cangi;* ***References and Fundings:*** *Mehmet Emrah Cangi, Ayşe Işıldar;* ***Materials:*** *Mehmet Emrah Cangi, Ayşe Işıldar.*

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