Kraaimaat, F.W. (1980). Clusters of disfluency and nonverbal behaviors of adolescent PWS and PWNS. In F.W. Kraaimaat, *Stuttering: a molecular analysis of stuttering behavior* (pp. 35-50). Lisse: Swets & Zeitlinger. (Translated from the Dutch)

Abstract

Factor analysis and cluster analysis were performed to classify the disfluencies and nonverbal behaviors that occurred while reading a 230-word passage of 48 adolescent PWS and 48 adolescent PWNS. Both condensation methods resulted in 5 groups of behavior for PWS and two groups for the PWNS. Behaviors characteristic of the PWS were found in 3 of the five groups. The first group consisted of non-verbal behavior during tense-block or prolongation. The second group was composed of fast repetitions of sounds and sound interjections. The third group consisted of the non-tense block. The other behaviors observed with PWS were placed in a fourth group composed of syllables, words, and phrases. Also, a fifth group was formed consisting of slow repetitions and interjections of sounds. The fourth and fifth group of the PWS were grouped in one cluster for PWNS. The second group of behaviors of the PWNS was composed of non-verbal behaviors (except for eye blinks) and non-tense block. Preliminary interpretations of the revealed groups of behaviors concerned the following functions: a) disruption in the sensomotoric program of speech movements that is manifested in irregularities in the coarticulation and coordination of breathing, phonation, and articulation, b) postponement, escape and avoidance of the PWS kernel disfluencies, c) a reflection of excessive muscle tension in the case of nonverbal behavior and e) deficits in syntactic skills such as delaying the decoding and for a short time memorizing of syntactic and meaningful parts of a text.

Keywords: classification of stuttering, PWS, PWNS, molecular analysis, adolescents

Introduction

Disfluencies are mostly studied using the classification suggested by Johnson (1955, 1961). A problem with this classification in 8 types of disfluency is that it masks differences between persons who stutter (PWS) and persons who do not stutter (PWNS). An objection with a priori classifications such as those of Johnson, primary or secondary stuttering (Bluemel, 1957), or type I and type II behavior (Brutten & Shoemaker, 1967) is that the interrelationship of the disfluencies that are combined was not empirically investigated. Contradictory data and interpretations might be the result. For instance, a finding that contingent punishment of prolongation (a type I behavior) does not lead to a reduction might be interpreted in various ways. It might be true that the other type I behaviors (phonemic repetitions and prolongations) are also not influenced by contingent punishment. On the other hand, it is also possible that the separate behaviors in this category are differentially influenced.

Brutten c.s. deal with this problem by advocating a molecular analysis of stuttering behavior. To study the differential effect of contingent negative stimulation, these authors studied the effect of contingent punishment separately on prolongations as well as tongue protrusion (Janssen & Brutten, 1974; Brutten, 1979). However, it is reasonable to assume that the same determinant rules interrelated behaviors, and thus, it is more efficient to study clusters of associated behaviors (e.g., Prins & Lohr, 1968). Moreover, a methodological and statistical benefit is that the combined and interrelated behaviors have higher reliability than separate behaviors.

The purpose of the present study was, firstly, to investigate the interrelationship of disfluencies and nonverbal behaviors of PWS and PWNS. Secondly, to perform an exploratory factor analysis and cluster analysis on these behaviors and compose groups of interrelated behaviors. Lastly, to propose possible determinants of the separate groups of behaviors revealed in PWS and PWNS.

Method

Subjects. The subjects were 48 young male PWS and 48 PWNS between the ages of 13 and 16 years. None of the PWS was in therapy at the moment of data collection. No subjects included in the PWNS group had a history of previous speech disorders.

Procedure. The subject's task consisted of the oral reading of a 230-word passage in the presence of an experimenter. Each subject was tested individually. All oral readings were recorded on a video recorder for later analysis.

Analysis of disfluency.

The speech sample was analyzed according to the following 15 types of disfluency: fast sound repetitions, fast (one syllable) word repetitions, prolongations, sound prolongations (within a word), tense blocks (blocks with concomitant inappropriate movements or fixations of the face or head), *non-tense blocks (also silent prolongations)*, vocalized blocks (blocks with concomitant audible struggle behavior), *sound interjections*, fast sound interjections, *word interjections, slow sound repetitions*, *slow syllable repetitions, slow word repetitions, phrase* repetitions, and breathing irregularities. The disfluency types which were included in the analysis for the PWNS are printed in italics. Mean percentage of agreement between two observers for judging different types of disfluencies was 83% (Sander, 1961).

Analysis of nonverbal behavior. Nonverbal behavior was defined as any observable movement of the orofacial structure that was not an integral part of the ongoing process of speech. Use was made of the 95-item Behavior Checklist (Brutten, 1974) to select 16 nonverbal behaviors which were combined in two categories: eye blinks defined as the fast closure of an eye or eyes and a rest category comprised of all other nonverbal behaviors. The choice for a rest category was due to a relatively low frequency of occurrence in PWNS and high variation among subjects.

Statistical analysis

Use was made of two condensation methods, an exploratory factor analysis (Principal axes, Varimax rotation, Kaiser normalization), and hierarchical cluster analysis (Johnson, 1967, maximum method). A restriction of the factor analysis is that variables have to be measured at an interval level and normally distributed. These restrictions do not apply to the hierarchical cluster analysis. However, a disadvantage of the latter method is that variables are only represented in one cluster. Both methods were performed with Spearman rank coefficients to deal with deviances from the normal distribution (Digman, 1966).

Results

Clusters of disfluencies and nonverbal behaviors of PWS

In Table 1, the Spearman rank correlation matrix is represented of the 17 behaviors of the PWS.

Table 1. Spearman rank correlation matrix of 17 behaviors of the PWS (n=48)

	Variables	1	2	3	4	5	6	7	8	9
1	Fast sound repetition	-								
2	Fast word repetition	.29	--							
3	Prolongation	.35	.06	--						
4	Sound prolongation	.03	.02	.04	--					
5	Non-tense block	.06	-.12	.22	-.04	--				
6	Tense block	.14	-.04	.42	-.16	.13	--			
7	Vocalized block	.06	-.01	-.04	-.20	.42	.05	--		
8	Sound interjection	.27	-.02	.10	-.25	.24	.34	.38	--	
9	Fast sound interjection	.46	.09	.39	-.03	.08	.37	.05	.35	--
10	Word interjection	.18	.08	.07	-.13	-.35	.14	.04	.12	.13
11	Breathing interjection	.34	-.02	.10	-.08	.24	.03	.27	.34	.10
12	Slow sound repetition	.37	.04	.25	.01	.08	.22	.24	.37	.14
13	Slow syllable repetition	.03	.11	-.02	-.20	-.12	.14	-.18	.07	.05
14	Slow word repetition	.25	.12	.16	-.16	.07	.30	.11	.28	.22
15	Phrase repetition	.18	-.01	.02	-.19	-.06	.23	.15	.41	.16
16	Eye blinks	.28	.03	.47	.01	.14	.54	.01	.35	.32
17	Rest nonverbal behavior	.42	-.02	.56	.16	.12	.67	.01	.23	.32
	Variables	10	11	12	13	14	15	16	17	
11	Breathing interjection	.05	--							
12	Slow sound repetition	.28	.39	--						
13	Slow syllable repetition	.07	.04	.16	--					
14	Slow word repetition	.17	.23	.32	.34	--				
15	Phrase repetitions	.29	.49	.26	.23	.64	--			
16	Eye blinks	.19	.20	.53	.21	.30	.26	--		
17	Rest nonverbal behavior	.14	.16	.37	.04	.28	.19	.58	--	

r > .28 then p < .05

An exploratory factor analysis was performed (Principal axis, Varimax rotation, Kaiser normalization) with the Spearman rank correlation coefficients calculated between the 17 variables. In Table 2, the factor loadings are represented of the six factors that were obtained.

Table 2. Rotated factor matrix obtained on 17 variables of the PSW (n=48)

		Factors						
	Variables	1	2	3	4	5	6	h2
1	Fast sound repetition	.30	.34	-.05	.03	-.03	.73	.73
2	Fast word repetition	-.03	-.01	.09	.07	-.03	.37	.15
3	Prolongation	.63	.05	-.04	-.11	-.08	.23	.47
4	Sound prolongation	.06	-.02	-.17	-.04	-.50	.02	.28
5	Non-tense block	.18	.23	-.17	-.69	.19	-.07	.64
6	Tense block	.80	-.04	.15	.05	.32	-.10	.78
7	Vocalized block	-.04	.40	-.28	-.26	.45	-.05	.50
8	Sound interjection	.26	.42	.02	-.04	.51	.09	.51
9	Fast sound interjection	.43	.03	.01	.01	.25	.44	.44
10	Word interjection	.14	.18	-.08	.66	.13	.09	.52
11	Breathing interjection	.04	.68	.04	-.10	.08	.10	.49
12	Slow sound repetition	.34	.57	.05	.10	-.01	.10	.46
13	Slow syllable repetition	.03	.01	.67	-.01	.05	.07	.45
14	Slow word repetition	.23	.37	.49	.09	.23	.11	.51
15	Phrase repetition	.09	.56	.41	.26	.31	-.01	.66
16	Eye blinks	.68	.29	.18	.04	-.01	.04	.58
17	Rest nonverbal behavior	.83	.21	-.03	.05	-.12	.06	.78

The cut-off score for the interpretation of the factors was >= .35.

Factor 1 comprised the following variables: *rest nonverbal* behaviors (.83), *tense block* (.80), *eye blinks* (.68), *prolongatio*n (.63), and fast sound interjection (.43). Factor 1 explains about 31 % of the total variance. The disfluencies that load relatively high on this factor have in common that they are associated with nonverbal behavior and represent a more severe form of stuttering.

Factor 2 included the variables: *breathing interjection* (.68), *slow sound repetition* (.57), phrase repetition (.56), sound interjection (.42), vocalized block (.40), and slow word repetition (.37). Factor 2 explains about 12 % of the total variance. A relatively high loading on this factor have disfluencies that differ between PSW and PWNS (breathing interjection, slow sound repetition, and slow word repetition) but also disfluencies that do not differ between both groups of subjects (sound interjection and phrase repetition). The latter type of disfluency might have the function in PWS to escape or avoid characteristics disfluencies such as blocks and fast repetitions as well as the result of deficiencies of syntactic and lexical skills.

Factor 3 contained the following variables: slow syllable repetition (.67), *slow word repetition* (.49), and *phrase repetition* (.41). This factor explains about 14 % of the total variance. The factor represents the characteristic disfluencies of PWNS and might indicate deficits in syntactic skills such as delaying the decoding and for a short time memorizing of syntactic and meaningful parts of the reading passage. However, these disfluencies have also a relatively high loading on factor 2, which might indicate in PWS also a function of escape and avoidance behaviors.

Factor 4 was comprised of *the non-tense block* (-.69) and word interjection (.66). This factor explained about 7 % of the total variance and can be seen as a disruption of sensomotoric skills. The negative loading of the non-tense block might indicate that word interjections function as avoidance of non-tense blocks.

Factor 5 comprised sound interjection (.51), sound prolongation (-.50) and vocalized block. This factor explained about 5 % of the total variance. Common in this factor is the interjection of sounds. Interpretation of this factor is hindered by the relatively low number of PWS that display these disfluencies.

Factor 6 includes *fast sound repetition* (.73), *fast sound interjection* (.44) fast one-syllable word repetition (.37). This factor explained about 4 % of the total variance. The common element in this factor is the fast repetition of a sound or sound unit. These disfluencies are characteristic of PWS and represent a disruption of sensomotoric skills.

In addition to the exploratory factor analysis, a hierarchical cluster analysis was performed (maximum method; Johnson, 1967) with the Spearman correlation coefficients calculated on the 17 variables of the PWS. Differences between both condensation methods are because in the cluster analysis a variable can only be presented in one cluster, while in factor analysis it is possible of a variable to have loaded on more than one factor. The hierarchical cluster analysis resulted in 5 clusters that are represented in the factors mentioned above in boldface and variables in italics. As can be seen, there is a high congruence between both condensation methods, which supports the robustness of the assigned groups of behaviors.

Next, five groups of disfluency were formed based on the corresponding results of the factor analysis and the hierarchical cluster analysis. The characteristic disfluencies of the PWS are represented in three groups, namely *Group a* (factor 1: rest nonverbal behavior, tense block, eye blinks and prolongation), *Group b* (factor 6: fast sound repetition and fast sound interjection), and *Group c* (factor 4: non-tense block). These types of disfluency are suggested to be a disruption in the sensomotoric program of speech movements that is manifested in irregularities in the coarticulation

and coordination of breathing, phonation, and articulation (e.g., Stromstra, 1965; Van Riper, 1971). The remaining *Group d* (factor 2: breathing interjection and slow sound repetition), and *Group e* (factor 3: slow word repetition and phrase repetition) comprised disfluencies that do not differ between PWS and PWNS (Kraaimaat, 1980). These type of disfluencies might be the result of deficits in syntactic skills such as delaying the decoding and for a short time memorizing of syntactic and meaningful parts of a text. Another possible function might be the postponement or avoidance of the PWS's characteristic disfluencies.

Clusters of disfluencies and nonverbal behaviors of PWNS (n=48)

Ten types of disfluency and 15 nonverbal behaviors were observed during the reading of the 230-word passage in the PWNS. The nonverbal behaviors were combined in two categories: eye blinks defined as the fast closure of an eye or eyes, and a rest category comprised of all other nonverbal behaviors. Clusters of disfluencies were explored employing an exploratory factor analysis (Principal axes, Varimax rotation, Kaiser normalization) as well as hierarchical cluster analysis (maximum likelihood; Johnson, 1967) was performed. Only variables were used that were revealed in at least 45 % of the PWNS (Table 3). Spearman rank coefficients were used in both analyses and are shown in Table 3.

Table 3 Spearman rank coefficients of 9 behaviors of the PWNS

Variables	*5*	*8*	*10*	*12*	*13*	*14*	*15*	*16*
5. Non-tense block	--							
8. Sound interjection	*.08*	--						
10. Word interjection	*.24*	*.52*	--					
12. Slow sound repetition	*.16*	*.52*	*.62*	--				
13. Slow syllable repetition	*.23*	*.43*	*.55*	*.57*	--			
14. Slow word repetition	*.15*	*.43*	*.64*	*.69*	*.71*	--		
15. Phrase repetition	*.08*	*.27*	*.44*	*.37*	*.42*	*.56*	--	
16. Eye blinks	*.18*	*.17*	*.19*	*.26*	*.19*	*.08*	*.01*	--
22. Rest nonverbal behaviors	*.37*	*.39*	*.26*	*.33*	*.27*	*.27*	*.23*	*.36*

r > .28 then p < .05

An exploratory factor analysis was performed (Principal axis, Varimax rotation, Kaiser normalization) with the Spearman rank correlation coefficients calculated between the nine variables. In Table 4, the factor loadings are presented of the two factors that were obtained.

Table 4 Rotated factor matrix obtained on the nine behaviors of the PWNS

	Factors		
Variables	1	2	h2
5. Non-tense block	.12	.40	.18
8. Sound interjection	.50	.34	.37
10. Word interjection	.72	.26	.59
12. Slow sound repetition	.72	.31	.61
13. Slow syllable repetition	.72	.22	.56
14. Slow word repetition	.92	.08	.86
15. Phrase repetition	.58	.06	.33
16. Eye blinks	.08	.47	.23
22. Rest nonverbal behaviors	.19	.75	.59

The cut-off score for the interpretation of the factors was >= .35.

Factor 1 was comprised of *slow word repetition* (.92), *slow syllable repetition* (.72), *slow sound repetition* (.72), *word interjection* (.72), *phrase repetition* (.58), and *sound interjection* (.50). This factor explains about 48 % of the total variance. The behaviors with relatively high loading on this factor may be interpreted as a type of disfluency that results from delaying the decoding and for a short time memorizing of syntactic and meaningful parts of the reading passage.

Factor 2 included *rest nonverbal behaviors* (.75), eye blinks (.47), and *non-tense block* (.40). This factor explains about 10% of the total variance. A common element of the behaviors of this factor might be some stagnation of the PWNS's sensomotoric skills. Note that in contrast with PWNS the behaviors in this factor were displayed by almost all PWS and also more frequent.

In addition to the factor analysis, a hierarchical cluster analysis (maximum method; Johnson, 1967), was performed with the Spearman rank correlation coefficients calculated on the nine variables. The results of the factor analysis and the cluster analysis corresponded highly (presented in italics in factor 1 and 2). Except for the exclusion of eye blinks (factor 2) in the cluster analysis. Note that eye blinks were not associated with the disfluencies of the PWNS (see Table 3).

The disfluencies of the PWNS are represented in two groups of disfluency. *Group a* (factor 1) represents a type of disfluency that is predominantly localized at a syllable, word, or phrase level. These disfluencies might result from the cognitive processes that are involved in the decoding and comprehension of the reading text. Some support for this contention comes from a study by Janssen & Kraaimaat (1979) were an association was found between reading errors and these disfluencies. *Group b* (factor 2) consisted mostly of nonverbal behaviors that are not associated in PWNS with a type of disfluency that occurs at the first sound of a word.

Summary and discussion.

The behaviors that might be attributed to irregularities in the coordination of breathing, phonation, and articulation (e.g., blocks, fast repetitions, prolongations) and behaviors that may function as escape and avoidance or be ascribed to syntactic or lexical skills (e.g., syllable and phrase repetition) were clustered separately in PWS. A characteristic feature was that the nonverbal behaviors of PWS were found to be associated with these irregularities. These findings, in combination with the differences found in the disfluencies between PWS and PWNS (Kraaimaat, 1980), are not in support of the contention that stuttering is a development from the normal disfluencies shown by PWNS.

More differentiated is the present statistical classification of disfluency in PWS in comparison with a priori classifications of stuttering in primary and secondary stuttering (Bleumel, 1957) or type I and type II stuttering (Brutten & Shoemaker, 1967). Fast repetitions, blocks, and prolongations are supposed to constitute the kernel disfluencies of PWS. The nonverbal behaviors that accompany these disfluencies are interpreted as a later stage in the development of stuttering. The fact that the characteristic disfluencies of the PWS were associated with breathing and sound interjections, and slow sound and word repetitions might be indicative of an escape or avoidance function of latter behaviors.

What factors might be involved in the groups of behaviors established in PWS and PWNS? In our earlier discussions, the following factors were mentioned:

a. A disruption in the sensomotoric program of speech movements that is manifested in irregularities in the coarticulation and coordination of breathing, phonation, and articulation.
b. Postponement, escape, and avoidance of the kernel disfluencies of the PWS.

c. A reflection of excessive muscle tension in the case of nonverbal behavior.
d. Deficits in syntactic skills such as delaying the decoding and for a short time memorizing of syntactic and meaningful parts of a text.

In Table 5, a summary is presented of possible interpretations of the groups of behaviors that were revealed in the PWS and PWNS.

Table 5. Review of groups of behaviors displayed in PWS and PWNS with a possible interpretation

	Disruption of sensomotoric skills	Deficiencies of syntactic and lexical skills	Excessive muscle tension	Postpone, escape or avoidance
PWS				
Group A: Tense block, prolongation, Rest nonverbal behavior, Eyeblink	X		X	
Group B: Fast sound repetition, Sound interjection, Fast word repetition	X		X	
Group C: Non-tense block	X			
Group D: Slow word repetition, Phrase repetition, Slow syllable repetition		X		X
Group E: Breathing interjection, Slow sound repetition, Sound interjection		X		X
PWNS				
Group a: Slow word repetition, Slow syllable repetition, Slow sound repetition, Word interjection, Phrase repetition, Sound interjection		X		
Group b Non-tense block Rest Nonverbal behaviors	X			

The above interpretations are preliminary. Research is warranted into the functions of the groups of behaviors distinguished in PWS and PWNS. Specifically of interest are studies into the relationship of the established groups of behaviors with linguistic and articulatory skills, and anxiety. Also, more effort is needed to develop reliable and valid diagnostic instruments to assess the functions mentioned earlier in children and adults.

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