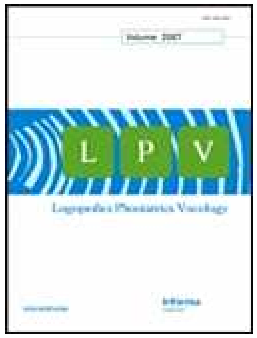

Characteristics of disfluency clusters in adults who stutter

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Characteristics of disfluency clusters in adults who stutter

Abstract

Background/Aims: The purpose of this study was to examine characteristics of disfluency clusters in adults who stutter (AWS) and to compare these characteristics to those previously reported for children who stutter (CWS).

Method: The spontaneous speech of ten AWS was sampled and organized according to utterance length in syllables. The overall number and type of disfluency clusters occurring in each sample were determined.

Results: Findings indicated that utterances containing disfluency clusters were significantly longer than fluent utterances and the occurrence of disfluency clusters was correlated with overall percentage of disfluency.

Conclusion: The results obtained in the present study for AWS tend to parallel those found for CWS and serve to validate their occurrence as feature of the disorder of stuttering.

Key words: adults, disfluency clusters, stuttering, utterances

Introduction

Currently, there is debate over the assignment of disfluency types to characterize the disorder of stuttering. Proponents of a disfluency-type measurement system date back to Johnson (1), who identified eight disfluency types (i.e., part-word repetition, single-syllable word repetition, polysyllabic word repetition, phrase repetition, disrhythmic phonation, tense pause, interjection and revision-incomplete phrase) that appeared to capture the full range of disfluencies exhibited by individuals who stutter. This system has been modified over the past ten years to primarily two types of classifications that are designed to separate disfluency types into those that are more common and less common in the speech of individuals who stutter (2-4). Stuttering-like disfluencies (SLDs) are those disfluencies indicative of chronic stuttering, and include part-word repetitions, single-syllable word repetitions, disrhythmic phonations, and tense pauses. Other disfluencies (ODs) are reflective of normal non-fluent speech and include polysyllabic word repetitions, phrase repetitions, interjections, and revision-incomplete phrases. Opponents of the use of disfluency-type measurement systems suggest that the systems lack measurement reliability, as well as evidence showing the predictive power of noting disfluency types (5-8).

Debates such as this are not unusual in the area of stuttering and highlight the differences in perspective among stuttering experts. In spite of these differences, there is agreement among various experts that using a disfluency-type measurement system allows for comparisons between people who do and do not stutter, and also serves to track the path of the disorder (6). The present study was designed with the intent of providing additional information regarding disfluency types as a means of further profiling the complexities of stuttering in children and adults. The specific type of disfluency examined is referred to as a disfluency cluster.

Disfluency Clusters

Silverman (9) was perhaps the first individual to note disfluency clusters, which he defined as the occurrence of two or more disfluencies on the same word and/or adjacent words. Since then, a number of studies have examined the production of disfluency clusters in children who do (CWS) or do not stutter (CWNS), with particular focus on the age period when both groups show high levels of disfluent speech. Wexler and Mysak (10) examined the production of disfluency clusters in a group of 36 CWNS aged 2-6 years. The children produced primarily single disfluencies, although approximately 18% of all disfluencies were produced as clusters. Colburn (11) performed a detailed analysis of disfluency cluster production in two-year-old CWNS. Disfluency clusters comprised approximately one-third of all disfluencies produced. The majority of the disfluency clusters were produced as two consecutive disfluencies; however there were instances when clusters exceeded six consecutive disfluencies. In addition, the majority of clusters contained disfluencies of the OD-type.

Hubbard and Yairi (12) examined disfluency clusters in both CWNS and CWS between the ages of 2-4 years. Similar to past reports for CWNS, approximately one-third of all disfluencies were produced as clusters. Among the CWS group, slightly more than half of all disfluencies were produced as clusters and the majority of clusters were found to contain at least one SLD-type disfluency. The researchers suggested that consideration of the occurrence and type of disfluency clusters might serve as a useful metric for the early identification of childhood stuttering. LaSalle and Conture (13) examined features of two-element disfluency cluster production in both CWNS and CWS between 3-6 years of age. Among the CWNS group, approximately one-half of all disfluencies were produced as clusters and the primary disfluency sequence of the cluster was OD-OD. Among the CWS group, approximately two-thirds of all disfluencies were produced as clusters with the most common sequence of the cluster being those containing one SLD-type element and one

OD-type element. In addition, there was a significant correlation between number of disfluency clusters and stuttering severity. LaSalle and Conture (13) supported the previous suggestion of Hubbard and Yairi (12), that consideration of disfluency clusters may provide diagnostic information concerning the presence and severity of a stuttering disorder in young children. Finally, Logan and LaSalle (14) were interested in determining specific grammatical factors that may 'trigger' disfluency clusters in CWNS and CWS. The CWS group was found to produce five times as many disfluency clusters as the CWNS group with the CWNS group producing a significantly greater number of clusters containing at least one OD-type element. For both groups, there was a trend for the number of disfluency clusters to increase as both utterance length and syntactic complexity (of utterances) increased.

Collectively, past research appears to provide a unified view of disfluency cluster production in children. Namely, both CWNS and CWS produce disfluency clusters during the preschool period (9-14). However, disfluency clusters are far more prevalent in the speech of CWS. Also, disfluency clusters are positively correlated with stuttering severity, and these clusters are likely to contain at least one SLD-type element (12-14). Unfortunately, the explanations offered by past researchers as to why these patterns occur are less unified. Still and Griggs (15) suggested that production of a single disfluency might serve to increase anxiety and physical tension that increases the probability of a "stuttering following a stutter." Hubbard and Yairi (12) offered a motor-based interpretation of disfluency clusters derived from Zimmermann's (16) organic model of disfluency. Accordingly, disfluencies result from a breakdown in coordination between the speech articulators. In the case of disfluency clusters, the failure of the speech motor system to restore itself, immediately following a moment of disfluency, results in over-flowing, unchecked maladaptive behavior. Logan and LaSalle (14) offered a linguistic interpretation of disfluency clusters based on tenets of the covert repair hypothesis (17). According to this hypothesis, individuals who stutter have a temporal impairment in their ability to phonologically encode words. The production of SLDs and ODs are a side-effect of the speaker's (covert) attempts to repair linguistic errors before they become expressed in overt speech (18). In the case of disfluency clusters, the production of two or more adjacent disfluencies may simply reflect a series of covert errors. However, LaSalle and Conture suggested that a moment of disfluency may result in a disruption in the sequential timing of phonological encoding, thereby precipitating disfluency on adjacent sounds, syllables, or words. Wexler and Mysak (10) offered both motor and linguistic interpretations for disfluency clusters depending on the particular composition of the cluster. Two-element clusters of SLD-SLD type were assumed to have an underlying motor component; while OD-OD type clusters were language based. Wexler and Mysak (10) did not offer an interpretation of "mixed" clusters. That is, those clusters containing both an OD and SLD disfluency.

The Present Study

Beyond the preschool period and into adulthood, distinguishing adults who stutter (AWS) from adults with no stuttering (AWNS) can be accomplished on the basis of a simple count of the total number of speech disfluencies or on the basis of a severity rating scale (4, 7). In both cases, the speech disfluencies demonstrated by AWNS are few and fleeting. The focus of the present study was not to differentiate AWS from AWNS but, rather, to determine whether the pattern of disfluency clusters produced by AWS parallels that found for CWS, as a means of charting the path of this peculiar feature of stuttering. Presumably, if disfluency clusters are a common occurrence in the speech of CWS, one would expect disfluency clusters to persist into adulthood. However, past accounts of disfluency clusters in CWS have attributed clusters to developmental demands in motor control, the complexities of language acquisition, or both (10, 12, 14). Therefore, it is possible that disfluency clusters are a unique feature of CWS and do not persist beyond periods of motor and linguistic maturation. Accordingly, the present research was guided by two general questions: 1) Do disfluency clusters exist in the speech of AWS? 2) If so, does the pattern of cluster production parallel that found for CWS in regard to the relationship between disfluency clusters and utterance length?

Method

Participants

A group of ten AWS (3 females, 7 males) with a mean age of 35-years participated in the study. No attempt was made to control for sex and all participants were free of known or reported hearing, neurological, intellectual or emotional problems. Stuttering diagnosis was made on the basis of self-report, case history information and assessment of the total number and type of disfluencies by a speech-language pathologist (SLP). Each participant engaged in informal conversation with a SLP for approximately 15 minutes. No attempt was made to control for the topic of conversation nor was instruction given to alter manner of speaking. Participants were seated at a table facing a video camera. A conversational speech sample consisting of the first 300-words spoken was obtained from each participant. The sample was taken to establish a baseline measure of the participants' disfluent speech prior to entering a stuttering therapy program. Moments of disfluency were identified and coded as either a SLD or OD, as defined by Ambrose and Yairi (20). The percentage of disfluencies (i.e., instances of SLDs and ODs) that were demonstrated by the participants ranged from 9% to 31% with a mean disfluency of 19%. The general characteristics of the participants are listed in Table 1.

[Insert Table 1 about here]

Data Transcription

Each participant's videotaped speech sample was transferred to a DVD format and orthographically transcribed verbatim. An utterance was defined as a string of words or clauses that a) communicate an idea, b) are set apart by pauses and c) are bound by a single intonational contour (19). The total number of syllables comprising each utterance was used as a measure of utterance length, excluding syllable, word and phrase repetitions. Unintelligible utterances, single-word utterances, and one-syllable utterances were deleted from the samples.

Disfluency Clusters

Each moment of disfluency was evaluated to determine whether it comprised a disfluency cluster. A disfluency cluster was defined as the occurrence of two or more disfluencies on the same word and/or adjacent words. Clusters were classified as, 1) SLD-type, which involved the occurrence of two or more consecutive SLDs (e.g., a part-word repetition followed by a disrhythmic phonation, "The b-b-boy wwent"; 2) OD-type, which involved the occurrence of two or more consecutive ODs (e.g., an interjection followed by a phrase revision "The man um -the boy went"; or 3) mixed-type, which involved the occurrence of both OD- and SLD-types (e.g., an interjection followed by a part-word repetition "He um w-w-wants").

Reliability Assessment

The first author performed all of the original transcriptions. Reliability for identification of disfluency clusters was performed randomly by choosing the speech samples of two participants. The samples were then re-listened to by the first and second authors, both of whom are SLPs, and the occurrence of all disfluencies and disfluency clusters was noted. The level of agreement for determining the presence/absence of a disfluency cluster was 100% for both intra- and inter- judge assessments. The agreement for determining the specific type of disfluency cluster (SLD, OD, or mixed) yielded an intra-judge reliability of 96% and inter-judge reliability of 81%. The corresponding kappa (k) values for intra-judge and inter-judgment of cluster type were k =.94 and k =.70, respectively. Both values were indicative of good reliability (21).

Statistical Analysis

A series of one-way analysis of variance (*ANOVA*) tests were used to evaluate differences in the types of disfluency clusters, and the average length of utterances containing no disfluencies, single disfluencies and clustered disfluencies. Any significant differences identified in the *ANOVA* test were further evaluated using follow-up t-tests. When significant differences were found, p-values were adjusted using the Bonferoni procedure to reduce to possibility of making a Type I error (22). The effect size was calculated for all significant t-test results using Glass' delta (Δ) statistic. Further, a series of correlational analyses were performed to evaluate the relationship between the overall percentage of disfluent speech and 1) number of disfluency clusters, and 2) percentage of clusters/total disfluencies. All analyses were carried out using SigmaStat Statistical Software (23).

Results

Disfluency Clusters

The distribution of disfluency cluster types for each participant is listed in Table 2. The total number of disfluency clusters across all participants was 144 and ranged from 6 to 23. The total numbers of SLD-type, OD-type and mixed-type disfluency clusters were 23, 28 and 93 respectively. To determine whether one particular type of disfluency cluster was more prominent than the others, the mean number of SLD-type, OD-type and mixed-type clusters for the group was tabulated and submitted to a one-way *ANOVA*. The test was significant [$F(2,29) = 44.25$, $p<0.001$]. Post-hoc Tukey tests were then performed to identify the source of the significant difference. The alpha level was adjusted to account for multiple *t*-test comparisons ($p= .05/3 = .016$). The results indicated that there were significantly more mixed clusters than OD-type [$q(18) = 3.31$, $p<.01$, $\Delta = 1.12$] or SLD-type clusters [$q(18) = 3.67$, $p<.01$, $\Delta = 1.21$]. There was no significant difference between the mean number of OD-type and SLD-type clusters. A Pearson product-moment correlation was calculated to examine the relationship between each participant's overall percentage of disfluency and corresponding number of disfluency clusters. Results indicated a significant positive relationship ($r(8) = 0.82$, $p<.05$), suggesting that as the number of overall disfluencies increased the number of disfluency clusters also increased. The correlation is not surprising considering that individuals with high levels of overall disfluency also had a large number and spread of disfluency clusters.

The number and percentage of elements per cluster for each participant is listed in Table 2. The total number of clusters across all participants with two elements, three elements and four (or more) elements was 108, 25 and 11 respectively. A one-way *ANOVA* was performed to determine if the proportional occurrence of disfluency clusters (regardless of cluster-type) differed according to the number of elements. Prior to performing the test, all percentage values were transformed to arcsine values. The test was significant [$F(2,29) = 44.25$, $p<0.001$]. Alpha-adjusted Tukey tests indicated there were significantly more two-element clusters than three-element clusters ($q(18) = 9.27$, $p<0.001$, $\Delta = 2.09$) or four-element clusters ($q(18) = 12.89$, $p<0.001$, $\Delta = 2.44$) clusters. There was no significant difference between the number of three-element clusters and four-element clusters ($p>.05$). Significant correlations were found between the percentage of disfluent speech and number of 3-element ($r(8) = 0.76$, $p<.05$) and 4-element clusters ($r(8) = 0.64$, $p<.05$).

[Insert Table 2 about here]

Utterance Length

The results regarding utterance length and amount of speech disfluency for each participant are contained in Table 3. The average length of fluent utterances was 8.4 syllables with a range from 5.8 to 12.8 syllables. The average length of utterances containing single disfluencies was 10.9 syllables with a range from 8.4 to 12.7 syllables. The average length of utterances containing disfluency clusters was 12.8 syllables with a range from 9.7 to 17.2 syllables. A one-way *ANOVA* was used to determine if utterance length significantly differed between fluent, single disfluencies and disfluency clusters. The test was significant [$F(2,29) = 18.68$, $p<.001$]. Alpha-adjusted post-hoc Tukey tests indicated that fluent utterances were significantly shorter than utterances with single disfluencies [$q(18) = 3.15$, $p<.005$, $\Delta = 1.19$] and clustered disfluencies ($q(18) = 8.62$, $p<0.001$, $\Delta = 2.11$). Utterances with single disfluencies were significantly shorter in length compared to utterances with disfluency clusters ($q(18) = 3.76$, $p<0.01$, $\Delta = .77$).

[Insert Table 3 about here]

Discussion

The first research question posed in the present study was whether disfluency clusters exist in the speech of AWS. All of the AWS sampled in the present study were found to produce disfluency clusters, thereby confirming that disfluency clusters are a feature in the speech of both CWS and AWS. However, the amount of clusters produced by the AWS accounted for no more than one-third of the total number of their disfluencies. This amount is lower than past reports for CWS, where disfluency clusters account for more than half of all disfluency types (12-13). The amount of disfluency clusters produced in AWS would suggest that, although clusters are still present in the disfluent speech of AWS, singleton disfluencies are a prevailing feature of adult stuttering typology. Logan (24) suggested that the stuttering behavior of CWS may be quite different from that of AWS due to the assorted linguistic and motoric challenges that confront young, developing children when learning to speak. Thus, it is possible these assorted challenges in overall development contribute to a high occurrence of disfluency clusters in CWS. However, among AWS, the processes of motor and linguistic development have reached their completion and should, presumably, no longer overtly affect speech fluency; at least not to the extent found in CWS. The higher number of disfluency clusters produced by CWS compared to AWS may be linked to processes of developmental maturation. Another possibility contributing to the lower number of disfluency clusters in AWS is to consider the influence of previous treatment for stuttering. Those participants who reported no prior history of stuttering therapy (Participants 4, 6-8) were those that tended to produce the highest number of disfluency clusters. We are intrigued by the notion of a relationship between prior treatment and the production of disfluency clusters, suggesting one of two likelihoods, 1) in the absence of treatment, disfluency clusters remain a prevalent feature in the speech of AWS and/or 2) among the various types of possible speech disfluencies, disfluency clusters are most likely to be reduced during the course of treatment. Future research examining the influence of treatment on disfluency clusters would be worthwhile.

Most disfluency clusters were 2-elements in length and over 60% of all disfluency clusters were of the mixed-type. The length and type of disfluency clusters produced by AWS parallels the results reported for CWS (12-13). Further, the overall percentage of disfluent speech was correlated with the number of overall disfluency clusters and number of 3-element and 4-element clusters. Past reports for CWS have likewise found that the frequency of disfluency clusters is correlated with stuttering frequency, and that children who produce a high number of clusters are inclined to exhibit more severe and chronic stuttering (13). Although severity of stuttering was not specifically examined in the present study, stuttering severity is typically related to the frequency of stuttering events (25). Thus, the present results appear to confirm the results found for CWS; namely, a high number of disfluency clusters is a primary feature among individuals with a high level of speech disfluency.

The second research question posed in this study concerned the relationship between disfluency clusters and utterance length. Utterances containing the fewest number of syllables were produced fluently more often than long utterances. The longest utterances were associated with the largest number of disfluency clusters. The observed differences in fluency according to utterance length are consistent with past studies for CWS (26-27). The relationship between utterance length and disfluency clusters also agrees with Logan and LaSalle (14), who found that the longest utterances (and those with the greatest syntactic complexity) produced by CWS were those that contained the largest number of disfluency clusters. Logan and LaSalle (14) offered a number of possible reasons for the occurrence of disfluency clusters in CWS. One such reason was to attribute disfluency clusters to grammatical effects that result from breakdowns in the process of formulating or coordinating multiple grammatical units within an utterance. This interpretation is linked to the covert repair hypothesis, whereby disfluencies are a result of an abnormally slow rate of phonological encoding (17). Disfluency clusters are a by-product of the repair process that spreads across adjacent speech units, with long utterances most prone to breakdowns in phonological encoding (13). Additional support for this contention is provided by Anderson and Conture (28) who found that CWS encode sentence structures (long utterances) more slowly than CWNS, which may contribute to an inability to produce fluent speech.

Hubbard and Yairi (12) suggested that disfluency clusters result from a breakdown in coordination between the speech articulators, whereby long utterances place the greatest demands on the resources needed for planning or executing speech. Wexler and Mysak (10) and others (14) have speculated that disfluency clusters are affected differentially by both motor and linguistic processes. Renewed support for the contentions raised by Hubbard and Yairi (12) and Wexler and Mysak (10) is provided by the execution and planning (EXPLAN) theory of Howell and Au-Yeung (29). These researchers propose that the production of disfluencies result from a dis-synchrony between speech planning and execution processes. That is, disfluencies may not reflect an error-prone phonological system but, rather, result from processes that occur “downstream” from phonological encoding (18). The types of disfluency, at points where fluency fails, can be divided into stalling and advancing disfluencies (29). Stalling disfluencies serves to provide the speaker with time to prepare for production of the ensuing (and more difficult to produce) word. Stalling does not occur because the words themselves are difficult, but because an up-coming word is difficult (29). Stalling disfluencies can generally be categorized as those that involve interjections and phrase/word repetitions (OD-type disfluencies). Advancing disfluencies occur on words that are difficult to produce, and involve breaks within words such as prolongations and sound repetitions (SLD-type disfluencies).

The EXPLAN theory has yet to be applied to the production of disfluency clusters but the proposal that certain types of disfluencies reflect locations where fluency fails fits nicely with the present results. For example, a majority of the disfluency clusters produced by the AWS were of the mixed-type, indicating that a combination of stalling and advancing processes were involved. Indeed, these combined processes may reflect speech disfluency in its fullest form, and is most apparent in long utterances. In addition, OD-type clusters and SLD-type clusters would reflect a series of stalling and advancing disfluencies, respectively. Although these clusters occurred with far lower frequency than mixed clusters, they confirm that the dis-synchrony between speech planning and speech execution processes can take various forms.

In conclusion, the debate continues as to the utility of measuring disfluency types in the assessment of stuttering. However, acknowledgement of disfluency types reflecting a symptom of the disorder is undeniable (23, 30). It seems clear that disfluency clusters are a feature of stuttering in both CWS and AWS. By comparing disfluency clusters in AWS to past results for CWS, the present data set assist in tracking a peculiar symptom of the disorder, from its earliest and simplest form, to its later and fully developed form. Assessment of the speech motor control behavior surrounding the production of disfluency clusters would be a logical 'next step' in resolving whether they are triggered by motor, linguistic, or dual processes.

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Table 1. General characteristics of the participants including age (in years), sex, percentage of disfluencies (%) per 100 words spoken, and history of treatment for stuttering.

Participant	Age (yrs)	Sex	% Disfluent	Previous treatment
1	51	Male	9	Yes
2	51	Male	20	Yes
3	23	Male	22	Yes
4	32	Female	9	No
5	23	Female	24	Yes
6	45	Female	26	No
7	18	Male	31	No
8	20	Male	20	No
9	37	Male	16	Yes
10	45	Male	12	Yes
Group M	35		19	

Table 2. Total number (#) and percentage (%) of clusters per participant and distribution of clusters based on type and number of elements.

		Cluster Type			Cluster Elements					
Participant	Total # clusters	SLD-type clusters	OD-type clusters	Mixed-type clusters	2 elements #	2 elements %	3 elements #	3 elements %	4+ elements #	4+ elements %
1	9	0	8	1	9	100	0	0	0	0
2	18	5	4	9	15	83	1	6	2	11
3	12	4	2	6	8	67	3	25	1	8
4	9	1	3	5	8	89	1	11	0	0
5	21	4	4	13	15	72	3	14	3	14
6	23	4	0	19	17	74	2	9	4	17
7	18	2	0	16	10	56	7	39	1	5
8	15	1	2	12	12	80	3	20	0	0
9	13	1	3	9	10	77	3	23	0	0
10	6	1	2	3	4	60	2	40	0	0
Total	144	23	28	93	108	-	25	-	11	-
Group M	14.4	2.3	2.8	9.3	10.8	76	2.5	19	1.1	5
SD	5.5	1.7	2.3	5.7	3.9	13.3	1.9	13.4	1.4	6.7

Note. SLD-type = two or more stuttering-like disfluencies (SLDs), OD-type = two or more other disfluencies (ODs), and mixed-type = both SLDs & ODs)

Table 3. Total number (#) of utterances and mean (M) utterance length (in syllables) for each participant. Utterances are organized according to those produced fluently, those containing instances of single disfluency, and those containing disfluency clusters.

	Fluent Utterances		Single Disfluency Utterances		Disfluency Cluster Utterances	
Participant	total #	M length	total #	M length	total #	M length
1	28	9.8	21	10.9	9	11.2
2	18	7.5	16	8.4	15	9.7
3	8	6.5	22	11.6	11	13.2
4	29	9.2	13	10.0	9	10.8
5	10	6.4	15	9.1	17	12.0
6	8	9.6	7	11.6	13	17.2
7	5	5.8	7	12.0	14	13.4
8	8	9.0	11	12.7	15	11.0
9	6	12.8	15	11.7	10	16.6
10	24	8.1	13	11.5	5	13.6
Group M	14.4	8.4	14.0	10.9	11.8	12.8
SD	9.4	2.0	5.0	1.3	3.6	2.4