January 2001

DURATIONAL, PROPORTIONATE, AND ABSOLUTE FREQUENCY CHARACTERISTICS OF DISFLUENCIES: A LONGITUDINAL STUDY REGARDING PERSISTENCE AND RECOVERY

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The main objective of this study was to investigate developmental aspects of disfluencies over time as stuttering persists or ameliorates for 2 groups of preschool age children who stutter. Results indicated that the frequency, type, and duration of disfluencies remained relatively constant instead of increasing as expected in the persistent group over a 3-year period. In contrast, the recovered group's initially higher frequency of disfluency decreased over time, as did their number of repetition units and proportion of disrhythmic phonations, while the duration of silent intervals between repetition units and proportion of monosyllabic word repetitions increased.

KEY WORDS: stuttering, development, disfluency, duration, recovery

Since Davis (1939) began systematic studies aimed at quantifying disfluencies in speech of young children, much of the subsequent research has attempted to delineate and compare the number and types of disfluencies produced by normally speaking children and children who stutter. A comprehensive review of the rich literature on this topic can be found in Yairi (1997). The findings of these studies have been used to support (Johnson et al., 1959) or refute (Yairi & Lewis, 1984) theoretical notions about stuttering, such as the diagnosogenic model. Information regarding the frequency/type of disfluency has also been applied clinically for the purpose of differential diagnosis between children who do and do not stutter (e.g., Adams, 1977; Pindzola & White, 1986).

Taking a somewhat different approach to the measurement of disfluent speech, several investigators analyzed children's disfluencies in terms of the proportion of each disfluency type (e.g., Yairi, 1972; Yairi & Lewis, 1984; Zebrowski, 1991). Their motivation was to investigate qualitative rather than quantitative differences by identifying disfluency patterns for groups that reflect the relative weight of each disfluency type instead of the absolute frequency. There were also a few attempts to consider the spatial distribution of disfluencies, that is, clustering (Hubbard & Yairi, 1988; Lasalle & Conture, 1995).

More recently, interest in the dimension of length of young children's disfluency has drawn increasing research activity. Two different metrics of length can be distinguished in this work. Ambrose and Yairi (1995,1999) investigated length as expressed in the number of iterations, or repetition units (a term first used by Johnson et al. in 1959) produced during part-word and monosyllabic word repetitions. They demonstrated that the number of repetition units is a powerful means for discriminating between groups of normally fluent and stuttering children. Zebrowski (1991), however, did not find a significant difference in the number of repetition units produced between normally fluent and stuttering children.

Other investigators interested in length have focused on the duration of disfluencies (e.g., Conture & Kelly, 1991; Kelly & Conture, 1992; Louko, Edwards, & Conture, 1990; Throneburg & Yairi, 1994; Yairi & Hall, 1993; Zebrowski, 1991). Zebrowski (1991) found no significant differences between the total duration of part-word repetitions and sound prolongations of stuttering and nonstuttering preschool children, although the repetitions of children who stutter were longer than their sound prolongations. Kelly and Conture (1992) also found no difference in the duration of within-word disfluencies between preschool age children who stuttered and normally fluent controls. Conture and Kelly (1991) reported that the longest within-word disfluencies were repetitions (1,015 ms), followed by whole-word repetitions (870 ms) and sound prolongations (727 ms) for preschool age children who stuttered.

In a preliminary report, Yairi and Hall (1993) drew attention to another duration measure of disfluency--the interval between the iterations (repetition units) of a particular segment. Although their sample contained a small number of children, they reported a trend (though not statistically significant) for stuttering preschool age children to have shorter intervals between the repeated units of monosyllabic word repetitions than their normally fluent peers. In a large follow-up study of more than 1,000 disfluent segments, however, Throneburg and Yairi (1994) found that preschool children who stuttered exhibited significantly shorter total duration of disfluencies than normally fluent children. The finding was attributed primarily to substantially shorter silent intervals between repeated units in part-word and word repetitions. In other words, children who stutter repeated faster. The duration of the silent interval between repeated units differentiated stuttering from normally fluent children with 85-87% accuracy for single-unit repetitions and with 72% accuracy for double-unit repetitions. In the same year, Zebrowski (1994) investigated duration of disfluencies in school age children who stuttered. She observed a negative correlation between the total duration of part-word repetition and the rate at which repetitions were produced. Children who produced repetitions with longer duration produced fewer repeated units per second. Children who produced more units of repetitions produced these repetitions at a faster rate. Zebrowski also found a positive correlation between the number and length of prolongations produced. Thus the interaction between rate, number of repeated units, and duration appears to be complex.

The studies cited above reported disfluency measures obtained at a single point in time. Other research has reported the developmental trends of childhood stuttering. Reports about preschool children's decreasing disfluencies over time, eventually resulting in large percentages of recovery from stuttering (Andrews & Harris, 1964; Yairi & Ambrose, 1992, 1999) also heightened interest in identifying early prognostic indicators for either recovery or persistency (Ambrose, Yairi, & Cox, 1997; Yairi, Ambrose, Paden & Throneburg, 1996). These reports, however, were based primarily on disfluency counts of a global index, stuttering-like disfluency (SLD), that combines the number of part-word repetitions, single-syllable word repetitions, and disryhthmic phonations. They suggested that many children who recovered could be differentiated from persisting participants based on the number of SLDs by 12 months after stuttering onset.

Whereas the investigators cited above also considered other prognostic factors (including phonological skills and patterns of familial inheritance of stuttering), they did not longitudinally investigate other disfluency parameters, such as specific disfluency types, proportional patterns of disfluencies, and the duration of disfluencies. It is interesting, however, that these disfluency parameters have been listed in existing prognostic instruments. For example, the Chronicity Prediction Checklist (Cooper & Cooper, 1985) lists (among others) the following predictors of chronic stuttering: (a) the presence of sound prolongations and blocks, (b) part-word repetitions with more than three units, (c) faster than normal tempo of repetition, and (d) prolongations longer than 1 second. The Stuttering Prediction Instrument for Young Children (Riley, 1981) lists risk criteria such as (a) more than three repeated units in part-word repetitions, (b) part-word repetitions repeated "abnormally," (c) presence of prolongations and blocks, and (d) frequency of disfluencies per 100 words. Conture (1990) stated that the high proportion (more than 25%) of sound prolongations might be indicative of persisting and that the duration of disfluencies decreases just before recovery. Unfortunately, many of these ideas were drawn from clinical impression, not from research-based data. For example, there has been no research on how the duration characteristics of disfluencies near the onset of stuttering change with time as the stuttering improves or worsens.

The overall frequency of stuttering-like disfluency in relation to persistency and recovery have been presented in other reports for a larger number of children by Yairi and his colleagues (e.g., Yairi & Ambrose, 1999; Yairi, Ambrose, Paden, & Throneburg, 1996). In this article, however, we examine the frequency and proportional occurrence of specific disfluency types. The number, rate, and duration of repeated units within part-word and monosyllabic word repetitions, and total duration of stuttering-like disfluencies, studied longitudinally as stuttering persisted or ameliorated in two groups of young children who stutter, are also reported. Because data from each child required extensive time-consuming analyses of acoustic data, the number of children in the present study had to be limited.

Method Participants

The participants were chosen from the pool of preschool children included in the longitudinal investigation of the Stuttering Research Project at the University of Illinois (Yairi, et al., 1996) that was available at the time this study was initiated in 1995. The children met the following multiple criteria to be admitted into the longitudinal stuttering research project at the University of Illinois: (a) age 6 or below, (b) regarded by parents as having a stuttering problem, (c) regarded by two investigators as having a stuttering problem, (d) stuttering history of no longer than 12 months, (e) stuttering severity rated by parents as at least 2 on an 8-point scale (0 = normal speech, 1 = borderline, 2 = mild stuttering, 3 = mild-to-moderate, 4 = moderate, 5 = moderate-to-severe, 6 = severe, 7 = very severe stuttering), (f) stuttering severity rated by investigators as 2 or higher, (g) exhibiting at least three stuttering-like disfluencies (SLDs include part-word repetitions, monosyllabic word repetitions, and disrhythmic phonation) per 100 syllables of spontaneous speech; and (h) no obvious neurological disorders or abnormalities.

The subset of children included in this study comprised two groups--persistent and recovered. Children who were classified as evidencing persistent stuttering when this study was initiated met the following criteria: (a) regarded by parents and investigators as having a stuttering problem, (b) stuttering severity rated as at least 2 on an 8-point scale for a minimum of 36 months after stuttering onset, and (c) currently continued to stutter at the last visit prior to initiation of this study. At the time this study began, 1 girl and 9 boys had continued stuttering for 36 months or more after stuttering onset and were included in the persistent group. Nine of these 10 children have been followed for an additional 4 years, and all continue to evidence stuttering in their speech. The 10 children classified as persistent stutterers ranged in age from 30 to 59 months, with a mean age of 43.4 months, at the time of their initial visit to the stuttering research project. None of the participants in the persistent group had received therapy prior to their initial visit to the stuttering research project when the first speech sample was recorded. Nine of the 10 participants in the persistent group received fluency therapy at later times for various periods but they persisted in stuttering despite therapy. One child did not receive therapy until after the time period covered in this study.

Children in the recovered group evidenced stuttering during at least two visits at the stuttering research project prior to being judged as recovered. Recovery occurred by 29 months post onset. Other children who recovered very quickly, and were only seen stuttering at one visit at our project, were not included in the present study's recovered group because the dynamics of how disfluencies changed as recovery occurred could not be described. The criteria for classifying a child as recovered included: (a) clinical judgment made by the investigators that the child did not exhibit a stuttering problem, (b) parent judgment that the child did not exhibit a stuttering problem, (c) parent rating of stuttering severity as less than 1, (d) investigator rating of stuttering severity as less than 1, (e) fewer than three SLDs per 100 syllables, and (f) continue to meet these criteria for at least 12 consecutive months. At the time this study was initiated 10 participants met the above criteria and had not received any speech therapy for fluency. These participants included 2 girls and 8 boys, ranging in age from 37 to 49 months (mean age = 41.9 months) at the time of the initial visit. At the present time, all of the recovered participants have maintained their recovered status for more than 4 years.

Speech Samples

Conversational speech was audio- and videotaped in a sound-treated room during the initial evaluation and follow-up visits every 6 months for a period of at least 3 years. Of course, at the time of the initial evaluation and first visits, the eventual development and classification of the children was not known. Each visit consisted of two sessions, separated by 1 week, during which a speech sample was obtained. Speech was recorded during verbal interaction with one parent and one investigator. Standard toys (e.g., Play-Doh) and questions were used to elicit conversation.

Speech samples were approximately 1,000 syllables. Seven disfluency categories or types were identified: (a) part-word repetition, (b) monosyllabic word repetition, (c) disrhythmic phonation (sound prolongations and blocks), (d) multisyllable word repetition, (e) phrase repetition, (f) interjection, and (g) revision/incomplete phrase. The first three disfluency types, termed stuttering-like disfluencies, were used in the analysis procedures of the present study.

Five of the project's staff members, each having several hundred hours of experience with disfluency analysis, transcribed the tapes orthographically and identified disfluencies. The recordings were played and replayed until the listener was satisfied that each instance of disfluency had been correctly identified and classified in the appropriate category. Each tape-recorded sample initially analyzed by the staff, was independently scrutinized again by the first author and a second senior investigator in the Stuttering Research Project. Interjudge reliability (point-by-point for location and type of disfluency) was .84. Interjudge reliability for counting the number of repetition units in part- and monosyllabic word repetitions between the staff members and the first author was .86. Following reliability calculations, some instances of disagreement were resolved through repeated listening. For the sake of consistency, however, the final classifications/counts were always determined based on the judgment of the first author and another senior investigator, who had the most experience with the tasks.

Recording Visits

Speech samples were obtained during the initial evaluation and follow-up visits every 6 months for a period of at least 3 years for the large group of children who participated in the stuttering research project. Speech samples from three visits per participant were analyzed for the purposes of this study. The initial evaluation, was held within 12 months of stuttering onset and was analyzed for participants of both groups. The mean post onset interval was 7 months (range = 5 to 12 months) for the persistent group and 5 months (range = 1 to 12 months) for the recovered group at the first visit. For the persistent group, a second speech sample was analyzed which was obtained at 19 to 24 months post-onset (M = 20 months), and a third sample was analyzed from a visit at 31 to 36 months post-onset (M = 32 months).

The children in the recovered group were judged to recover from stuttering at different times from 13 to 29 months post stuttering onset. A second sample (in addition to the initial visit) was analyzed while the recovered children were still stuttering and within the first 2 years of stuttering onset. The time of this prerecovery visit ranged from 7 to 23 months post onset (M = 13 months). Third samples were analyzed from the visit when recovery criteria were first met, at 13 to 29 months post-onset (M = 19 months). This was termed the "postrecovery" visit.

Duration of Disfluencies

The marked transcripts of the tape-recorded speech samples for the three visits of each group were inspected to select disfluent segments for acoustic analysis. A minimum of two and maximum of 10 instances of each of the following disfluency types per visit per participant were chosen: (a) part-word repetitions with one unit (e.g., b-but), (b) part-word repetitions with two units (e.g., b-b-but), (c) part-word repetitions with three units (e.g., b-b-b-but), (d) monosyllabic word repetitions with one unit (e.g., but-but), (e) monosyllabic word repetitions with two units (e.g., but-but-but), (f) monosyllabic word repetitions with three units (e.g., but-but-but-but),and (g) disrhythmic phonations (e.g., blocks such as b-ut, or prolongations, mmmmmy). Given the above criteria and qualifications, the durations of 1,669 disfluent events were measured from their acoustic signals. When a participant produced more than 10 disfluencies of a particular type, the first 10 measurable disfluencies were used. Because the number of available disfluencies of each type differed among children, mean values for duration were first calculated for each participant rather than combining the productions of all children. Group data were then derived from these individual means so that each participant was weighted equally.

Instrumentation

Participants' conversational speech during verbal interaction with an adult was audio-recorded in an IAC sound-proof room using a Crown PPC-160w phase coherent cardioid microphone. The microphone was connected to a Yamaha KM608 preamplifier (mixer). The audio signal was then directed to a Tascam 122 MKII stereo cassette recorder with Maxell II S-90 recording cassette tapes.

For acoustic analyses, the audio signal was transmitted through a low-pass filter (Frequency Devices Model 901) with a high-frequency cutoff at 7.5 kHz to one channel of a Data Translation 2821 series analog-to-digital (A/D) converter board that interfaces with a microprocessor-based personal computer. A software system for digital signal processing of the acoustic signal, CSpeech Version 4 (Milenkovic, 1995), was used. Disfluent events, as defined above, that met the criteria of being clear of interfering noise, were low-pass filtered at 7.5 KHz, digitized at 20,000 samples per second, and stored on a computer disk. Acoustic measurements were made from an FFT-based spectrogram display and corresponding time waveform (Milenkovic, 1995).

Acoustic Measurement of Duration

To increase the accuracy of determining the onset and offset points of measured speech segments, expanded representations of both the time waveform and corresponding FFT-based spectrographic display of each disfluency were visually inspected and verified through playback of the auditory signal. The duration of identified sound prolongations was measured from the onset of acoustic energy associated with the prolonged sound to the cessation of its acoustic energy. In the case of blocks within words, the period of cessation of acoustic energy associated with a fixed articulatory posture (Conture, 1990), and no voicing was measured. Onset and offset points were systematically determined by manipulating the vertically oriented cursors, using the spectral energy of specific segments, the time waveform and audio playback of the speech sample. When onsets and offsets could not be reliably identified, that disfluent event was excluded. A sample of the visual display of a prolongation is presented in Figure 1 with cursors placed at the initiation and termination of the prolonged sound.

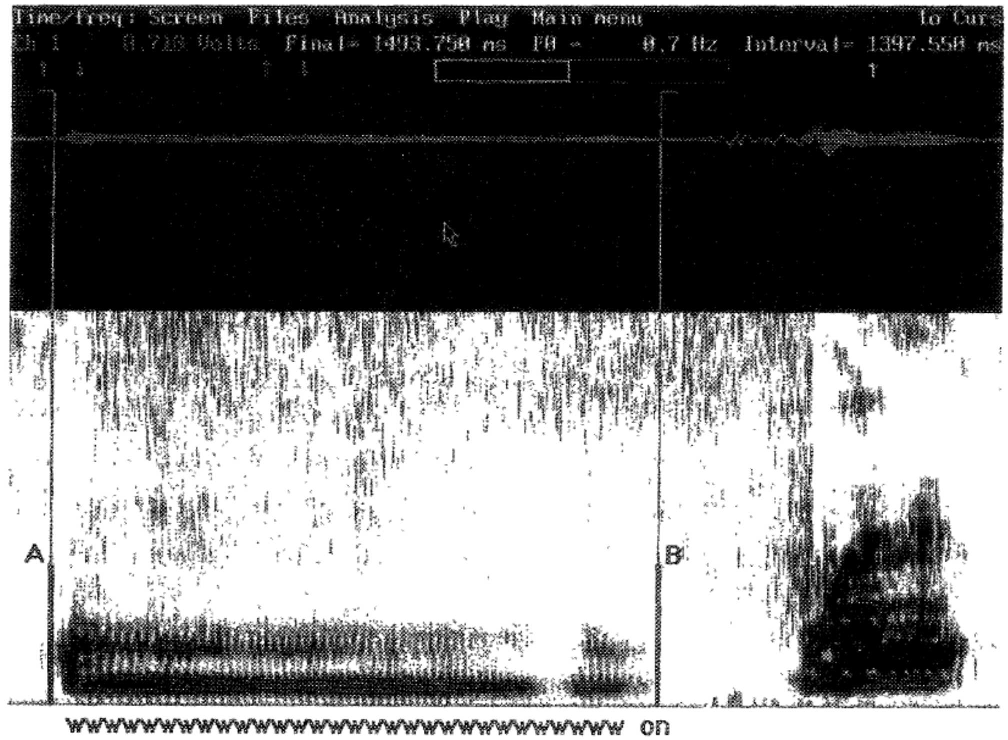

Figure 1. An example of an FFT-based spectrogram used to measure the duration of a sound prolongation from initiation (A) to termination (B).

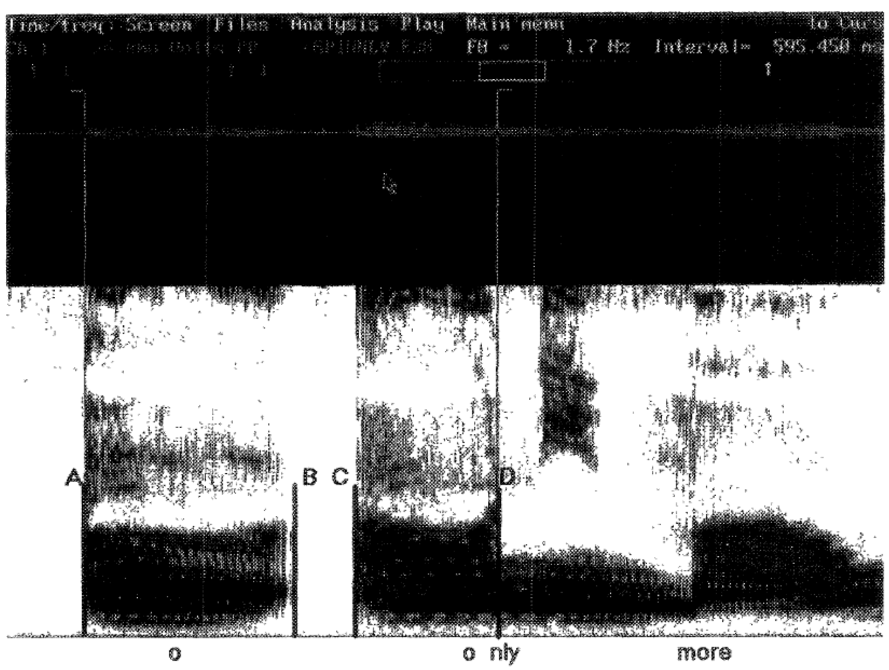

Figure 2. An example of an FFT-based spectrogram used to measure a part-word repetition with one repeated unit. A-B is duration of first spoken unit, B-C is duration of silent interval, C-D is duration of final spoken unit, A-D is total duration.

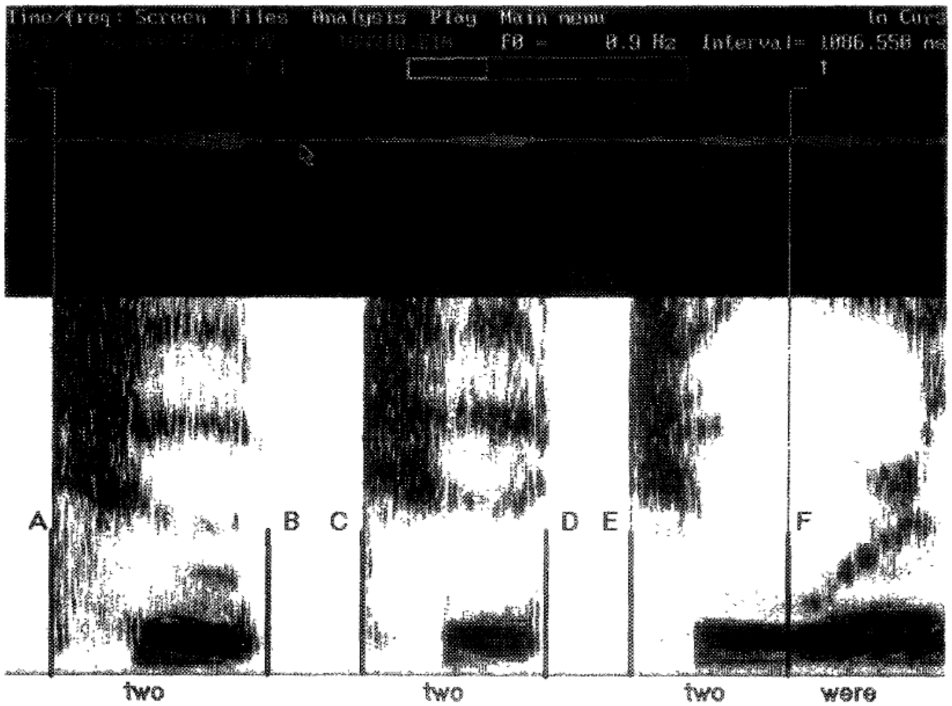

Figure 3. An example of an FFT-based spectrogram used to measure a monosyllabic word repetition with two repeated units. A-B is duration of first spoken unit; B-C is duration of first silent interval; C-D is duration of second spoken unit; D-E is duration of second silent interval; E-F is duration of final spoken unit; A-F is total duration.

For part-word and monosyllabic word repetitions, the duration was measured for the entire disfluency as well as for each repeated unit and the interval between unit(s) that constituted that event. Duration was measured from the onset of acoustic energy associated with the initial disfluent sound in the word to the cessation of acoustic energy for the iteration of the repeated sound, syllable, or word. Onset was visually defined as the first peak (maximum amplitude in millivolts) that corresponded with a burst of spectral energy of the spectrogram. When spoken segments where followed by silent intervals (e.g., the interval between the segments bu-but), the offset was defined as the last consecutive peak. Although the effect of coarticulation could not be controlled for, when the repeated spoken segment was immediately followed by another consonant or vowel (that is, there was no silent interval), the boundary was determined by examining changes in formant direction and/or declination in spectral power associated with the termination of the repeated sound. The boundaries were also verified through auditory playback of marked segments. A sample of the visual display of a part-word repetition is presented in Figure 2.

For single-unit part-word repetition (e.g., o-only), the initiation and termination of the first spoken segment (points A and B), the silent interval (points B and C), the repeated portion of second spoken segment (points C and D) were marked. The durations in milliseconds between each pair of points and between point A and D (total duration) were determined for each disfluent episode in this classification (see Figure 2).

For monosyllabic word repetition with two repeated units (e.g., to-to-to), the duration of the first spoken segment (points A and B), the first silent interval (points B and C), the second spoken unit (points C and D), the second silent interval (points D and E), the final spoken segment (points E and F) and total duration (between points A and F) were measured in milliseconds (see Figure 3).

All acoustic measurements were performed by the first author. Intrajudge reliability for these data were calculated by the first author remeasuring 10% of the segments of each of the seven types of disfluencies (a total of 165 disfluencies). Pearson's correlation coefficient between the two sets of data was .97. Interjudge reliability between the investigator and another experimenter for acoustic measurements was calculated in a similar manner as just described. The Pearson correlation was .95.

Results

Results reported in the following sections include the frequency of disfluency types, their proportional distribution, number of repetition units, total duration for the different types of disfluencies, duration for segments within part- and monosyllabic word repetitions, and the rate of repetition production for part- and monosyllabic word repetitions. Data for each measure will be presented for the initial visit. Next, longitudinal data for second and third visits will be presented. For the persistent group the three visits covered a period of 2 years. For the recovered group, the first two samples were obtained from visits prior to recovery whereas the third sample was obtained from the visit when recovery criteria were first met. Comparisons will not be made between the groups of children at the second and third visits because they occurred at different post onset intervals.

Frequency, Proportions, and Repetition Units of Speech Disfluencies The Distribution of Disfluency at the Initial Visit

In Table 1, the first row of data for each of the two groups presents the detailed frequency, proportion, and repetition units information at the initial visit. At that time, most of the participants in the persistent group exhibited moderate-to-severe stuttering. Their mean SLD per 100 syllables was 9.47. The corresponding mean for the recovered group was 16.17, indicating greater stuttering frequency. Results of a multivariate analysis of variance for the frequency of stuttering-like disfluencies (part-word repetition, monosyllabic word repetitions, and disrhythmic phonations) indicated there was a significant difference between the groups at the initial visit, $F(3,16) = .542$, $p = .005$. Follow-up univariate tests indicated there was a significant difference between the groups in the frequency of monosyllabic word repetitions ($p = .002$), but not the frequency of part-word repetitions ($p = .07$) or disrhythmic phonations ($p = .84$).

Group/visit	Part-word Repetition	Monosyllabic Word rep	Disrhythmic Phonation	Total SLDs	Repetition Units
Persistent					
<12 months	4.89 (.49)	3.06 (35)	1.53 (.16)	9 47	1 41
19–24 months	4 48 (49)	2 64 (.34)	1.89 (17)	9.00	1 51
31–36 months	3.50 (44)	2 34 (39)	1 38 (17)	7 21	1 31
Recovered					
<12 months	8.44 (.50)	6.32 (42)	1.41 (.08)	16 17	1 74
prerecovery	2.31 (.40)	3.01 (53)	.37 (.07)	5.70	1 36
post-recovery	85 (.44)	1 07 (.55)	.03 (01)	1 95	1.10

Table 1. Mean frequencies of stuttering-like disfluencies per 100 syllables, the mean proportion of each type of disfluency within the total number of stuttering-like disfluencies (in parenthesis), and the mean number of repetition units in part-word and monosyllabic word repetitions for recovered and persistent participants at the initial evaluation less than 12 months from stuttering onset and at two later visits.

For both groups at the initial visit, part-word repetitions constituted the largest proportion (approximately 50%) of the total SLD, with monosyllabic word repetitions second, and disrhythmic phonations third. Proportionally, the persistent group produced twice as many (16%) disrhythmic phonations within the total SLD than the recovered group (8%). An arcsine transformation was applied to the proportional data and the differences between the groups were analyzed using a multivariate analysis of variance. Results of the MANOVA indicated there were no significant differences between the groups in the proportional distribution of disfluencies at the initial visit $F(3,16) = .208$; $p = .28$.

The recovered group produced a larger mean number of repetition units per instance of part-word and monosyllabic word repetition than the persistent group (1.74 vs. 1.41). This difference, however, did not reach statistical significance, $F(1,18) = 3.355$, $p = .08$.

Changes in the Distribution of Disfluency Over Time

Results of a repeated-measures MANOVA indicated that the change in the frequency of stuttering-like disfluencies across visits was not significant for the persistent group over time, $F(3,6) = .81$, $p = .29$. The proportional distribution of disfluencies remained quite stable over the entire period of observation, with part-word repetitions as the dominant disfluency type. There was no change in the proportion of disrhythmic phonation in the persistent group. Arcsine transformations were applied to the proportional data and a repeated-measures MANOVA indicated there was not a change in the proportional distribution of disfluencies over time for the persistent group $F(4,6) = .36$, $p = .86$. The number of repetition units also remained consistent over time $F(2,18) = .35$, $p = .71$.

As the children in the recovered group reached and passed the recovery criteria, their disfluencies pattern changed and monosyllabic word repetitions became the most frequent disfluency type, whereas disrhythmic phonation almost disappeared. Arcsine transformations were applied to the proportional data. Results of a repeated-measures MANOVA indicated there was a significant change across visits in the proportional occurrence of disfluencies for the recovered group, $F(4,6) = .94$, $p = .02$. Follow-up univariate tests indicated the significant change occurred in the proportional occurrence of disrhythmic phonation ($p = .003$) as it declined with time to 1% of the total SLD. During the process of recovery, the children also decreased the mean number of repetition units within repetitions from 1.74 initially to 1.10. The final number was similar to that reported for normally fluent children (Yairi & Lewis, 1984). The recovered group's change across visits in the mean number of repetition units was significant, $F(2,18) = 8.34$, $p < .01$.

Total Duration of Disfluencies

Measurements of total duration in milliseconds were obtained for the three disfluency types that constitute stuttering-like disfluencies. The mean total duration for repetitions with different numbers of repeated units was calculated separately. All children who produced a minimum of two measurable disfluencies for any given type were included in group means for that type. Monosyllabic word repetitions of three units occurred too infrequently to be analyzed. In the recovered group, none of the children produced sufficient measurable part-word repetitions of three units at the pre- and post-recovery visits, or of monosyllabic word repetitions of two units or disrhythmic phonation at the post-recovery visit. Data for the total duration of disfluencies for each group at each visit for part-word repetitions with one, two, and three units, monosyllabic word repetitions with one and two units, and disrhythmic phonation are presented in Table 2.

Group/visit	Part-word repetitions			Monosyllabic-word repetitions		Disrhythmic phonation
	1-unit	2-unit	3-unit	1-unit	2-unit	
Persistent						
<12 months	553 90 (95 74) *n* = 10	994.41 (204.70) *n* = 8	1197 76 (149.46) *n* = 5	686.22 (102 47) *n* = 10	1004 24 (293 13) *n* = 8	631.57 (211.26) *n* = 7
19–24 months	527.82 (92 71) *n* = 10	975.39 (278 68) *n* = 6	1162.53 (196.96) *n* = 6	800 76 (160 34) *n* = 10	1239.71 (329.51) *n* = 7	676 50 (185 94) *n* = 6
31–36 months	520.91 (83.03) *n* = 10	784 30 (170 74) *n* = 7	1105 65 (202 02) *n* = 2	708.62 (181 19) *n* = 10	1122 18 (292 15) *n* = 6	824.17 (349 92) *n* = 6
Recovered						
<12 months	592.76 (163 23) *n* = 10	1115 90 (180 26) *n* = 9	1478.92 (331 16) *n* = 5	804.75 (233.25) *n* = 10	1389.40 (451 92) *n* = 9	621 00 (90 92) *n* = 4
prerecovery	629.35 (195.82) *n* = 10	1141.75 (145 12) *n* = 3	———	826.49 (134.36) *n* = 10	1276 50 (319.15) *n* = 8	646 50 (168 96) *n* = 4
post-recovery	672.29 (220 31) *n* = 10	1059 00 (412 34) *n* = 2	———	908.58 (234.30) *n* = 10	———	———

Table 2. Mean total duration of disfluencies and standard deviations (in parenthesis) for children who persist in or recover from stuttering over three visits.

Total Duration of Disfluencies at the Initial Visit

A MANOVA revealed there were no statistically significant differences in the mean duration of part-word and monosyllabic word repetitions with one to two units between the groups at the initial visit [$F(4,10) = .54$, $p = .71$]. Part-word repetitions with three units and disrhythmic phonation were not analyzed statistically because of the smaller number of participants who produced two or more measurable disfluencies.

Change in Total Duration of Disfluencies Over Time

There were sufficient data for only part-word and monosyllabic word repetitions of one unit to be statistically analyzed meaningfully over the three visits. The magnitude of the reduction in multiple unit repetitions and disrhythmic phonation left too few data points across any given subject to allow inclusion of the other variables in the analysis (i.e., different subjects were missing data points for different disfluencies, and any blank took that subject out of the analysis).

A repeated measures MANOVA was performed to evaluate the change in duration of one-unit part-word and monosyllabic repetitions across the three visits. Results indicated nonsignificant changes for the persistent group [$F(4,5) = 2.08$, $p = .22$] or the recovered group [$F(4,6) = .16$, $p = .95$].

The table reveals considerable within-group variation as evidenced by the standard deviation values. Differences between groups or across visits for all of the measures are relatively small.

Duration of Segments Within Monosyllabic Word Repetitions

The mean absolute duration of the various segments within monosyllabic word repetition with one and two repeated units is presented in Table 3. The duration of the spoken repetition units and the silent interval(s) between spoken repetition units is included and expressed in milliseconds. The rate of repetition was calculated by dividing the number of spoken units by the total duration of the disfluency and is expressed in units per second. Data for double-unit monosyllabic word repetitions are not presented for the recovered group's post-recovery visit because there were not enough instances from which to obtain individual and group means.

Duration of Single-Unit Word Repetitions at the Initial Visit

Results of a multivariate analysis of variance for the segments within monosyllabic word repetition with a single repeated unit revealed there were no significant differences between the groups in any of the segments at the initial visit, $F(3,18) = .678$, $p = .578$.

Changes in the Duration of Single-Unit Word Repetitions Over Time

Table 3 indicates that the duration of the spoken units in single-unit word repetitions showed relatively little changes across visits for either group. The duration of the final (second) repetition unit, however, was shorter than the initial repetition unit for both groups at all visits. There was a significant difference between the duration of the first and second repetition unit, F(1,18) = 44.97, p < .001.

For the persistent group, a repeated-measures MANOVA indicated that there were no statistically significant differences over time for any of the segments within single-unit word repetitions, F(4,6) = .45; p = .82.

Although the recovered group's initial silent interval duration of 226 ms increased to 370 ms at the post-recovery visit, a repeated-measures MANOVA revealed that none of the changes in duration for segments within single-unit word repetitions were significant for the recovered group, F(4,6) = 2.05, p = .25.

Group/visit	1st repetition unit	1st interval	2nd repetition unit	2nd interval	3rd repetition unit	Rate
	Single-unit repetition					
Persistent						
<12 months	270 (105)	169 (65)	246 (45)	—	—	2.94
19–24 months	295 (52)	259 (149)	246 (50)	—	—	2.50
31–36 months	273 (83)	216 (200)	218 (52)	—	—	2.81
Recovered						
<12 months	315 (64)	226 (189)	262 (52)	—	—	2.50
prerecovery	300 (58)	295 (124)	230 (32)	—	—	2.42
post-recovery	299 (63)	370 (189)	239 (43)	—	—	2.20
	Double-unit repetition					
Persistent						
<12 months	243 (59)	140 (120)	254 (43)	155 (117)	209 (32)	2.98
19–24 months	292 (71)	140 (85)	315 (94)	224 (136)	267 (73)	2.42
31–36 months	261 (32)	203 (135)	276 (75)	167 (133)	213 (33)	2.66
Recovered						
<12 months	300 (92)	259 (185)	323 (111)	264 (197)	240 (47)	2.15
prerecovery	301 (76)	199 (114)	338 (120)	209 (102)	226 (42)	2.35

Table 3. Means durations in milliseconds and standard deviations (in parenthesis) for the various segments within single- and double-unit monosyllabic word repetitions and the rate of repetition per second for children who persist in or recover from stuttering over three visits.

Duration of Double-Unit Word Repetitions at the Initial Visit

Table 3 also presents the measures for monosyllabic word repetition with two repeated units (e.g., but-but-but). The duration of repetition units was similar for the two groups. A repeated-measures analysis of variance revealed that there were no significant differences between the groups in the duration of the spoken units, F(1,15) = 3.16, p = .09. There was, however, a significant difference between the initial repetition units and the final (third) production for both groups F(2,30) = 8.31, p = .001. The interaction between group and spoken unit was not significant, F(2,30) = .71, p = .498. A multivariate analysis of variance, however, revealed there were no significant differences between the groups in the duration of segments within monosyllabic word repetitions with two repeated units at the initial visit, F(5,11) = .79, p = .57.

Changes in Duration of Double-Unit Word Repetitions Over Time

There does not appear to be large change in the way the persistent group produced double-unit monosyllabic word repetitions over the three visits. Statistics were not performed on differences across time for either group because of the smaller number of participants who produced two or more measurable double-unit monosyllabic word repetitions at later visits.

Duration of Segments Within Part-Word Repetitions

The mean absolute duration of the various segments within part-word repetition with one and two repeated units is presented in Table 4. The duration of the spoken repetition units and the silent interval(s) between repetition units are included and expressed in milliseconds. The rate of repetition was calculated similarly to that described earlier.

Duration of Single-Unit Part-Word Repetitions at the Initial Visit .F.T.-The duration of the spoken repetition units within single-unit part-word repetitions was similar for the two groups at the initial visit. A multivariate analysis of variance revealed there were no significant differences between the groups in the duration of segments within part-word repetition with one repeated unit at the initial visit, $F(3,16) = 2.00$, $p = .15$.

Group/visit	1st repetition unit	1st interval	2nd repetition unit	2nd interval	3rd repetition unit	Rate
	Single-unit repetition					
Persistent						
<12 months	256 (53)	97 (56)	200 (40)	—	—	3.61
19–24 months	208 (35)	134 (56)	184 (43)	—	—	3 79
31–36 months	223 (34)	113 (65)	184 (21)	—	—	3.84
Recovered						
<12 months	238 (70)	133 (77)	221 (48)	—	—	3.37
prerecovery	236 (62)	209 (113)	183 (35)	—	—	3 17
post-recovery	224 (90)	264 (133)	183 (49)	—	—	2.97
	Double-unit repetition					
Persistent						
<12 months	263 (103)	125 (108)	264 (80)	125 (105)	215 (51)	3.02
19–24 months	207 (51)	161 (113)	226 (93)	178 (119)	200 (74)	3.08
31–36 months	185 (46)	129 (129)	212 (91)	79 (68)	177 (56)	3.82
Recovered						
<12 months	259 (66)	136 (82)	293 (55)	147 (100)	278 (110)	2.69
prerecovery	244 (23)	275 (271)	273 (24)	113 (98)	235 (32)	2.63
post-recovery	173 (8)	258 (149)	182 (25)	217 (141)	227 (155)	2.83

Table 4. Means, durations in milliseconds, and standard deviations (in parenthesis) for the various segments within single- and double-unit part-word repetitions and the rate of repetition per second for children who persist in or recover from stuttering over three visits.

Changes in Duration of Single-Unit Part-Word Repetitions Over Time

The duration of the repetition units was similar for the two groups and did not appear to change over time. For both groups, the duration of the first repetition unit (range = 208 to 256 ms) tended to be longer than the final repetition unit (range = 183 to 221 ms). There was a significant difference between the duration of the first and second spoken repetition unit, $F(1,17) = 58.17$, $p < .001$.

A repeated-measures MANOVA indicated there were no significant changes in the segments within part-word repetitions for the persistent group over time $F(3,6) = .81$, $p = .29$. A repeated-measures MANOVA indicated there were no significant changes in the segments within part-word repetitions for the recovered group over time $F(4,6) = .84$, $p = .12$.

Duration of Double-Unit Part-Word Repetitions at the Initial Visit .F.T.-A multivariate analysis of variance revealed there were no significant differences in the segments within double-unit part-word repetitions between the groups, $F(5,11) = .339$, $p = .40$.

Changes in Duration of Double-Unit Part-Word Repetitions Over Time

Statistics were not performed on differences across time for either group because of the small number of participants who produced two or more measurable double-unit part-word repetitions at later visits.

Discussion

The main motivation of this study was to further pursue the differentiation between two subgroups of young children who stutter, those who persist and those who recover, on disfluency parameters not investigated before. This was done by comparing the groups when they were first evaluated soon after stuttering onset (and had not received therapy), a point when their eventual classification was not known yet. Both groups were then followed longitudinally as stuttering persisted for one, but ameliorated for the other. The distribution characteristics of several types of disfluency, as well as measures of length of disfluency, were analyzed.

Initial Differences

The primary findings of the present study indicate that soon after onset there were very few significant differences in measures of disfluencies between children who eventually became persistent and those who recovered from stuttering. Although the study found few statistically significant differences initially between the groups, acceptance of the null hypotheses of no differences between the groups should be done only with great caution. There is a critical need for replication of the current study by other independent investigators. The current results are important, however, in that they are the first to question many existing beliefs about differences between children who will persist or recover from stuttering, which have influenced clinical decisions and counseling.

The results for the present subset of participants reflect findings reported for a much larger number of stuttering children (Yairi & Ambrose, 1999), indicating that at the very early stage of stuttering the overall level of stuttering-like disfluency is not an indicator of risk for persistency. In fact, the children who eventually recovered were more disfluent at the initial visit than the children who persisted. Additionally, no statistically significant differences were found in the initial patterns of the proportional distribution of disfluencies. For both groups, more than 80% of stuttering-like disfluencies at the first visit consisted of part-word repetition and monosyllabic word repetition. Disrhythmic phonation was a considerably less prominent feature.

The more detailed analysis in the present study also allows for a better assessment of existing prognostic instruments. Although the present study was based on only 20 children, the data do not support those instruments that suggest that a high frequency of disfluencies and a large number of repetition units constitute danger signs for persistence. The Chronicity Prediction Checklist (Cooper & Cooper, 1985) considers disfluency on 5% or more of words uttered for periods of 6 months as indicative of chronic stuttering. In the present investigation, both the recovered and persistent groups met this criterion at the initial visit. Similarly, according to the Stuttering Prediction Instrument for Young Children (Riley, 1981) disfluency instances containing three or greater repetition units are signs of impending persistent stuttering. Again, the present data show that neither group produced an average of more than three repeated units. Also the tendency of the persistent group to have a higher proportion of disrhythmic phonation at the early stage of stuttering was not significant and failed to support current assumptions in this regard (Conture, 1990; Curlee, 1980, Riley, 1981, Van Riper, 1982).

There are also several important observations from the durational data. First, findings for the total duration of disfluency at the initial visit appear to be comparable to several previous reports (Conture & Kelly, 1991; Kelly & Conture, 1992; Zebrowski, 1991). Based on the present and past reports for somewhat different ages and length of stuttering history, we conclude that the duration of repetition and disrhythmic phonation average less than 1 second within the first 3 years of stuttering.

Second, the nonsignificant differences between the groups are again useful in assessing existing clinical beliefs as they do not support the assumption made in the Stuttering Prediction Instrument (Riley, 1981) and the Chronicity Prediction Checklist (Cooper & Cooper, 1985) that longer blocks and prolongations serve as warnings of persistence. Both groups produced disrhythmic phonations that averaged approximately 650 ms long at the initial visit.

In general, it appears that the contradictions discussed above may possibly be explained by age differences and the length of the stuttering history. A review of existing prediction instruments reveals that many of the items appear to pertain to children who have stuttered for longer than children in the present study who were first seen within 1 year of stuttering. Therefore, although high level of disfluency and larger number and proportion of disrhythmic phonation may be a differentiating factor later in the development of stuttering (Yairi et. al., 1996), they are not at the very early stage of the disorder. Such contradictions point out the need for continued validation of prediction instruments with careful longitudinal investigations that trace the disorder from very early stages.

Developmental Trends Persistent Group

When evaluating the developmental trends of stuttering-like disfluencies produced by the persistent group, the expected increases were not observed. Although none of the persistent participants received intervention prior to the initial visit within the first year of stuttering onset, 9 of the persistent participants received some therapy at different times within the first 3 years of stuttering onset. The type, frequency, and duration of intervention were not controlled for in the present study. Therefore, the developmental trends of disfluency productions by the persistent group must be interpreted cautiously in this regard.

Both the overall level of SLD and proportional distribution of the three specific types of disfluency remained relatively stable, with part-word repetitions being the dominant disfluency type for the persistent group. These findings raise questions concerning the traditional views that, as a rule, the disorder becomes progressively worse and that sound prolongations and blocks increasingly become the dominant feature of stuttering (Bloodstein, 1961). For example, the Stuttering Prediction Instrument (Riley, 1981) emphasizes increased severity of disfluencies as an indication of persistence. Our reservations in regard to these views are limited to the first 3 years after onset of the disorder. This, however, is the critical period for which prognosis is most urgent. It is possible that the developmental trends described in previous sources take place at later stages of the disorder.

The nonsignificant change in the duration and rate of repetitions over a 2-year period (within the first 3 years of stuttering onset) for the persistent group, did not agree with expectations. Again, although statistically nonsignificant, these findings are still important in evaluating traditional assumptions. The data contradict the notions that, as stuttering continues, repetitions become more rapid and irregular (Bloodstein 1960a, 1960b, 1961; Froeschels, 1921; Van Riper, 1982). In fact, the total duration of disfluencies was similar to that found by Zebrowski (1994) for school-age children who stutter, providing more support for our suspicion that little change is taking place in this parameter for several years after onset.

One of the most provocative observations was the static nature of the persistent group's stuttering symptoms in light of the rapid language and motor development that takes place during this period. We are tempted to hypothesize that in a substantial number of cases the disturbed system causing stuttering remains quite stable for at least the first 3 years after onset, suggesting that the role of learning during early stages of stuttering is more limited than what has often been assumed (Starkweather, 1997). Nevertheless, one cannot ignore the fact that some children who persist eventually develop more severe problems. Whether this reflects inherent characteristics that are slow to emerge or the impact of increasing awareness and emotional reactions, is a challenging question. The possibility that exposure to clinical intervention may have contributed to the lack of escalation of the disorder must also be considered. But one must also recognize that these children continued to stutter in spite of treatment while, at the same time, the recovered group improved without treatment.

Recovered Group

The fact that the recovered children began with considerably more disfluencies than the persistent group could be the result of a sampling error. The decision to include only recovered children who evidenced stuttering during at least two visits prior to recovery may have increased the chance of more severe recovered participants being selected initially. The same tendency, however, has been observed in larger, unselected samples (Yairi & Ambrose, 1999). Regardless, the findings show that there is not a direct relation between the developmental outcome in stuttering and the initial level of disfluency as measured in this study.

Generally, children in the recovered group, who did not receive therapy, exhibited more changes in their disfluencies than did the children in persistent group who did receive therapy. The data indicate that recovery involves several dimensions. Not only is there a reduction in the number of disfluent events, there is also reduction in the mean number of repetition units that, by the post-recovery visit, fell within the normal range (Yairi & Lewis, 1984). Additionally, there are changes in the proportional composition of the types of disfluencies. As part-word repetition declines, monosyllabic word repetition becomes relatively more prominent whereas disrhythmic phonation all but disappears. The present trend for slower repetition rate to be associated with the normalization process in the recovered group, although nonsignificant, should be further researched.

Clinical Implications and Conclusions

In general, the present data seem to indicate that once stuttering begins, much of its development during the first 3 years following onset takes the direction of reduction and normalization, as well as some stabilization in the persistent children, rather than aggravation of the condition. This conclusion is also supported by the high rates of spontaneous recovery (Yairi & Ambrose, 1999). Aggravation does, of course, occur but it is the less typical case. Even though awareness and emotional reactions may be developing within the first 3 years of stuttering onset, they do not seem to have a substantial impact on the disfluent behavior of persistent children.

Based on the results of this study, it would appear that current clinical notions and instruments concerning predicting chronic stuttering need to be carefully reassessed. Perhaps they were formed on the basis of impressions derived from children who sustained stuttering for longer periods, when their chronic status was closer to being established. The present findings re-emphasize the need for clinicians to observe clients over time. Trends of decreasing frequency of disfluency, increasing the proportion of monosyllabic word repetitions, decreasing the proportion of disrhythmic phonations, decreasing number of units in repetition, and increasing intervals within repetitions are all positive signs of recovery, whereas lack or minimal change of disfluency is more indicative of persistence (in contrast to previous suggestions of looking for an increase in severity).

In addition to replication of the current findings with larger groups of children, further investigation into specific characteristics of part-word repetitions may be revealing. The early change from part- to whole-word repetition in the recovered group along with Stromsta's (1965) observation that perhaps persistent stuttering is characterized by fractured syllables, whereas transient stuttering is characterized by whole syllable repetitions, suggests the specific nature of the part-word repetitions produced by these groups warrants further study.

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