

Disfluency Clusters of Children Who Stutter: Relation of Stutterings to Self-Repairs

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The purpose of this study was to account for the frequency, type, and possible origins of speech disfluency clusters in the spontaneous speech of 3- to 6-year-old children, 30 who stutter and 30 who do not stutter. On the basis of the Covert Repair Hypothesis (Postma & Kolk, 1993), which suggests that stutterings are the by-products of self-repairs or self-corrections of speech errors, three hypotheses were tested in attempts to account for the frequency and location of stutterings within speech disfluency clusters. Sequences of various types of speech disfluencies in utterances containing disfluency clusters were collected from audio/videotaped conversations between each of these 60 children and their mothers. Three types of speech disfluencies—overt self-repairs, covert self-repairs, and within-word disfluencies ("stutterings")—and the disfluency clusters they comprised, were identified and analyzed frame-by-frame. Results indicated that children who stutter produced significantly more stuttering-stuttering clusters (e.g., "I-I-I w-w-want . . ." or "w-w-waaaant") and that, although children who do not stutter occasionally produced stutterings, they never produced stuttering-stuttering clusters. Furthermore, children who stutter produced significantly more stuttering-repair clusters, whereas children who do not stutter produced significantly more repair-repair clusters. Within the disfluency clusters of children who do not stutter, stutterings were more likely to follow an overt self-repair produced at a relatively fast speaking rate (6.6 sylls/sec). Findings are taken to suggest that stuttering-stuttering clusters may help differentiate between children who do and do not stutter, and that speech errors, self-repairs, and speech disfluencies influence one another within and between adjacent sounds, syllables, and words in what appears to be a nonhappenstance and theoretically important fashion.

KEY WORDS: stuttering, disfluency clusters, children, self-repairs, speech disfluencies

The "clustering" of speech disfluencies refers to the tendency for between- and within-word disfluencies to closely precede or follow one another, in various sequences, during the conversational speech of children who stutter (CWS) and children who do not stutter (CWNS) (Colburn, 1985; Hubbard & Yairi, 1988; Silverman, 1973).¹ Such clustering appears to be an integral part of the onset and development of childhood stuttering (Curlee, Adams, Conture, Gregory, & Costello Ingham, 1993; Healey, 1991). That is, although CWNS occasionally produce disfluency clusters (Colburn, 1985; Silverman, 1973), they produce significantly fewer and significantly shorter speech disfluency clusters than do CWS (Hubbard & Yairi, 1988). Despite these clinical and research observations, there is still no readily apparent explanation for *why* speech disfluencies tend to cluster together.

Hubbard and Yairi (1988) have suggested, however, that objective study of the

¹Normally fluent children who are not considered to have a stuttering problem, but who produce an average of 0-2 within-word disfluencies or "stutterings" per 100 words of conversational speech, will hereafter be termed "children who do not stutter" as per recent ASHA guidelines to use "people who" terminology.

"internal composition of clusters" (p. 232) may provide important insights into why "disfluencies [appear to] beget disfluencies" (Hubbard & Yairi, 1988, p. 232). Indeed, it seems quite possible that the occurrence of only certain types of speech disfluencies "beget" stuttered types of speech disfluencies, resulting in the clustering of speech disfluencies. One seemingly plausible explanation for this occurrence may be found in the Covert Repair Hypothesis (CRH) of stuttering (Postma, 1991; Postma & Kolk, 1993), in particular as it is applied to childhood stuttering (Kolk, Conture, Postma, & Louko, 1991).

The CRH: A Brief Overview

The CRH is grounded in "connectionist" or "activation-spreading" models of speech production (e.g., Dell, 1986, 1988; Levelt, 1983, 1989, 1991). In brief, such models attempt to account for the generation of speech by assuming a network of connected nodes (e.g., nodes at the word form, syllable, and segmental levels), a quasi-neurological account for certain aspects of speech and language processing. Many details of this processing (e.g., the rate and direction of activation spreading between connected nodes), thought to be involved with the transformation of thought to overt speech, appear to vary considerably depending upon one's theoretical perspective (e.g., Dell, 1986; Levelt, 1989). Whatever the case, the CRH extends the tenets of these theories in attempts to account for stuttering. In essence, the CRH posits that the self-repairs of people who stutter reflect an attempt to accommodate or adapt to their temporally impaired (i.e., slower) ability to "phonologically encode," that is, to build or retrieve an articulatory plan (Kolk, 1991; Kolk et al., 1991; Postma, 1991; Postma & Kolk, 1992, 1993; Postma, Kolk, & Povel, 1991; Wijnen & Boers, 1994). Based on the aforementioned connectionist notion of "activation-spreading," the CRH suggests that the intended phonemes of CWS are slower to activate than those of CWNS. Thus, relative to CWNS, the intended phonemes of CWS are more apt to remain in competition with unintended phonemes for a longer period of time. This longer period of competition among intended and unintended phonemes is thought to increase the chances that CWS will mis-select speech units during the process of phonological encoding, something that is even more likely to occur if the child engages in inappropriately fast selection of speech units.

The CRH further suggests that even before these unintended speech errors become part of overt speech, they may be detected by the use of an "internal monitor," which assesses what is called "internal speech" or "an internal representation of how the planned utterance should be articulated" (Levelt, 1989, p. 12). Of course, internal monitoring does not preclude the speaker from also "externally monitoring" his or her overt speech output, for example, by means of audition. When a speech error occurs, internal monitoring may lead to internal detection of the error, although it is probable that not all errors that arise in internal speech are detected. Once a speech error is internally detected by the speaker, he or she may then stop or "cut off" ongoing speech, repair the error and, as the CRH suggests, stutter as a by-product of this process. Some-

times the error-to-correction process is *overt* as in "*He—she goes,*" and such a process can be directly observed and measured. Conversely, the process is sometimes *covert* and one can only infer that internal revising has occurred because of hesitations that surface in overt speech, as in "*Uh she goes.*" The *covert* portion of the CRH label implies that internal monitoring, error detection, and self-repair is occurring, for which overt evidence is not readily available.

The CRH and Speech Disfluency Clusters

There are several reasons for believing that application of the CRH to the phenomenon of speech disfluency clusters may help assess the CRH's ability to account for a known phenomenon of childhood stuttering and provide a better understanding of that phenomenon. First, the CRH makes an explicit attempt to account for the "immediate causation of the stuttering event" (Kolk, 1991, p. 135), and, since speech disfluency clusters constitute one aspect of "the stuttering event," it should be possible to use the CRH to account for the frequency and nature of speech disfluency clusters. Thus, the fact that speech disfluency clusters are empirically measurable, as are certain aspects of speech errors and self-repairs contained within them, should permit data collection with which reasonable inferences could be made about the processes of speech errors, self-repairs, and disfluencies described by the CRH, processes seemingly involved with immediate causation of stutterings.

Second, not only may speech disfluencies "cluster" together, but self-repairs, or between-word disfluencies, may cluster with stutterings, or within-word disfluencies. Thus, if the process of self-repairing, whether overt or covert, has any relation to stutterings on adjacent sounds, syllables, or words (e.g., an antecedent word influencing a subsequent word or subsequent influencing antecedent word), one would expect to observe "repair-stuttering" or "stuttering-repair" sequences or disfluency clusters.

Third, while the CRH does not preclude the possibility that supra-phonemic errors (e.g., morphemes, words, phrases, clauses) are involved with stuttering (e.g., Postma & Kolk, 1993), it does suggest that, for CWS, phonemes are the most likely speech units to be problematic. This CRH suggestion stems from the facts that stuttering behavior generally affects sounds or phonemes to a greater degree than larger speech units, and that 30%–40% of CWS exhibit concomitant phonological disorders (e.g., Louko, Edwards, & Conture, 1990; Wolk, Conture, & Edwards, 1990). Thus, for example, temporary changes in the rate of selection of phonemes resulting from self-repairs may increase the frequency or change the nature of speech errors, self-repairs, and disfluencies on surrounding words, something that detailed examination of repair-stuttering sequences should reveal.

In general, then, we wanted to know if the clustering of stutterings and/or self-repairs could provide insights into childhood stuttering as well as help us assess the ability of the CRH to account for this phenomenon of childhood stuttering. To do this, three interrelated, seemingly reasonable hypotheses were developed from the CRH premise that stutterings result from adaptations to detected speech er-

rors. What follows is each of these three hypotheses and an explanation of their relationship to CRH tenets.

"*Hypothesis one*" states that stutterings occur on words within the boundaries of an overt error, preceding a cutoff, that is, on "overt error words," more often than they occur on other words in disfluency clusters. This hypothesis was based on the CRH tenet that stutterings are precipitated or "triggered" by error detection and/or repair. This first hypothesis would be supported if significantly more stutterings were found to coincide with overt error words (e.g., occurring on the word "was" in "*I w-w-was going—I am going*") than with other words in the disfluency cluster (e.g., occurring on the word "going" in "*I was going—I am g-g-going*"). If this first hypothesis were supported, stutterings in certain disfluency clusters would not likely be by-products of the overt repair process because they would precede, rather than follow, the cut-off and repair processes.

Conversely, "*hypothesis two*" states that stutterings occur on covert error words more often than they occur on other words in disfluency clusters. This hypothesis was also derived from the CRH tenet that stutterings are "triggered" by error detection and/or repair. This second hypothesis would be supported if significantly more stutterings were found to coincide with covert repairs (e.g., on the word "going" in the phrase repetition "*I was g-g-going—I was going to the store*") than with other words in the disfluency cluster (e.g., on the word "to" in "*I was going—I was going t-t-t-to the store*"). If this second hypothesis were supported, it would appear more likely that stutterings in clusters are by-products of covert error detection and/or covert repairs, rather than by-products of overt error detection and/or repairs, or of some other unknown cause.

Finally, "*hypothesis three*" states that stutterings are likely to occur after overt errors and/or repairs produced at a relatively fast articulatory speaking rate. This third hypothesis follows from the CRH tenet that inappropriately fast rates of initiating and/or maintaining speech unit selection may precipitate or "trigger" stutterings in CWS, because these children are theorized to have a slower capacity for phonological encoding. It was thought possible that children in either talker group may, during and after the time they detect and cut off an overt error, try to make up for "lost time" and increase their rate of unit selection and their articulatory speaking rate during an overt self-repair. If children speak faster while self-repairing, this may increase the probability that they will stutter on subsequent sounds, syllables, or words. This third hypothesis would be supported if a significantly faster speaking rate were found in overt errors and in resulting overt repairs up to the point of a stuttering than would be found in overt errors and repairs up to the point of other speech disfluencies. For example, the articulatory speaking rate (in syllables per second) of the first 5 syllables in the disfluency cluster "*I was go—I am g-g-going*," may be faster than the syllables in overt errors and repairs preceding other self-repairs.

Thus, the purpose of the present study was to objectively examine the frequency and nature of speech disfluency clusters in the conversational speech of children who do and who do not stutter, and test hypotheses derived from the Covert Repair Hypothesis in attempts to explain the fre-

quency, type, and possible origins of these disfluency clusters.

Method

Subjects

Subjects were 60 monolingual children, aged 3–6 years, and their mothers. Thirty children who stutter (CWS) (M age = 51.2 MOs; SD = 10.6 MOs) were matched by age and sex to 30 children who do not stutter (CWNS) (M age = 51.5 mos; SD = 10.4 mos). There were 24 boys and 6 girls in each talker group. Subjects were paid volunteers from the Central New York area and were naive to the specific purpose of the study. None of the children in either talker group had received speech/language treatment prior to the time of audio-videotaping.

Children who stutter (CWS). A child was classified as a CWS if he or she met the following criteria: (a) exhibited three or more within-word disfluencies per 100 words, based on a 300-word conversational speech sample; and (b) had people in his or her environment who had expressed concern regarding speech fluency and/or believed that the child is a stutterer or highly at risk for becoming one.

For the 26 of the 30 CWS whose parents reported it, post-onset or "time since onset" of stuttering averaged 16.5 months (SD = 8.4 mos), findings similar to those of Yaruss and Conture (1993). The children's stuttering severity was rated by the first author, using the Stuttering Severity Instrument (SSI) (Riley, 1981), and verified by the second author. These ratings were based on the children's stuttering behavior exhibited during their conversations with their mothers, during the time they were audio/videotaped. Ten of the 30 CWS were rated as "mild" (overall scores: 10–15), 19 of the 30 were "moderate" (overall scores: 16–23), and 1 was "severe" (overall score = 24).

Children who do not stutter (CWNS). A child was classified as a CWNS if he or she met the following criteria: (a) exhibited two or fewer within-word disfluencies per 100 words; and (b) people in the child's environment had not implicitly or explicitly expressed concerns about speech fluency or expressed the belief that the child is a stutterer or at risk of becoming one.

Excluded subjects. The 60 children were selected from an original pool of 90 potential subjects (2–6-year-olds) who were reported to have no problems other than stuttering for the CWS, had obtained most developmental milestones, exhibited *normal* fine and gross motor control, hearing sensitivity and impedance, expressive and receptive language, and voice. Of these 90 children, 30 children (15 from each talker group) were excluded from the original pool for the following reasons: (a) 7 CWS and 2 CWNS were "phonologically disordered," that is, they demonstrated at least one age-inappropriate or atypical phonological process (Edwards & Shriberg, 1983; Louko, Edwards, & Conture, 1990; Stoel-Gammon & Dunn, 1985; Wolk, Edwards, & Conture, 1993); (b) 4 CWS and 1 CWNS were at or below the 10th percentile on the Developmental Sentence Score (Lee, 1974); (c) 2 supposed CWS produced fewer than 3 within-

Data Collection

The subjects' associated audio signals were obtained using two wireless FM transmitter (Samson, Model CRX-3)/microphone (Samson, Model BT-3) units with retrofitted lapel microphone attachments (Sony, ECM-Model 55). Lapel microphones were placed within 15 cm of the mother's and the child's lips, fed to separate audio channels, and simultaneously recorded and monitored throughout recording on separate VU meters located on the front of the Panasonic VCR.

Data Analysis

Speaking rate of overt error/repair syllables. The third hypothesis was tested by locating the maximum number of syllables within overt errors and/or associated overt repairs that led up to, but did not include, the second element of interest. The second element of interest was the stuttering

²Hubbard and Yairi (1988) defined "clusters" as the occurrence of two or more disfluencies on the same word or on adjacent words. The criterion of including speech disfluencies within a "finite clause" (Levett, 1989) was added to the operational definition of a cluster so as to account for only those disfluencies that occur within the same utterance, rather than across or between utterances. Hubbard and Yairi attempted to limit clusters to only those adjacent disfluencies that occur within utterances, but their Monte Carlo simulation method of analysis precluded them from doing so.

TABLE 1. Definitions, subtypes, and examples of four basic types of speech behaviors. Adapted from Blackmer and Mitton (1991); Bredart (1991); Evans (1985); Kolk et al. (1991); Levelt (1983, 1989); Postma, (1991); Postma & Kolk, (1993). Examples of subtypes are shown in boldface, in context with actual 3- to 6-year-old children's utterances, italicized and placed in quotation marks.

Behavior	Definition	Subtypes: "examples"
Overt errors (OEs)	Perceptible, nonsystematic deviations from a speech plan. ^a	One-word: " <i>You— we fight.</i> " Word group: " <i>He forgot to p— he says something's missing.</i> " Erroneous: " <i>No, when I never c— when I call somebody I never do that.</i> " Inappropriate: " <i>Dat's why— why do Tricia have a baby in her tummy?</i> "
Overt repairs (ORs)	Revisions; include a "cutoff" (—) of an overt error and an alteration of it. (Overt repairs of overt errors are boldfaced).	Production-based: (a) phonological: " <i>You cooped me up— you scooped me up.</i> "; (b) morphological: " <i>He tell— is telling they he's way up there.</i> "; (c) lexical: " <i>It can talk— maybe it can talk to all of 'em.</i> " Appropriate-level: " <i>Elephants don't eat peop— eat some boys with him trunk, right?</i> " Different-message: " <i>But do you like volc— but volcanoes are very, very hot.</i> " "Repair-on-the-fly": " <i>This is Little Boy Blue, this one.</i> "
Covert repairs (CRs)	Restarts and postponements that do not contain overt errors and are NOT stutterings.	Editing terms: " <i>uh</i> "; " <i>um</i> "; " <i>I mean</i> " Phrase repetitions of entire words: " <i>Who is that— who is that other person?</i> " Phrase repetitions of cut-off words: " <i>He be— he better protect the baby.</i> " Polysyllabic whole-word repetition: " <i>It gots circle-circle things.</i> " "Slow" monosyllabic whole-word repetition: " <i>Cause . . . [>250 msec] 'cause this time . . .</i> "
Stutterings (STs) ^b	Restarts and postponements of sounds and syllables.	Whole-word repetition: " <i>And [<250 msec] -and only put one bed in there.</i> " Sound-Syllable repetition: " <i>A-a-and he got something in there.</i> " Audible prolongation: " <i>And a illittle boy gave it to somebody.</i> " Inaudible prolongation: " <i>—Dey</i> [tense articulatory posture for /d/] <i>gonna get on.</i> " Broken word: " <i>Mommy, does-oes this fly?</i> "

^aSubtypes of ORs, CRs, and STs are mutually exclusive, but subtypes of OEs are not. That is, an OE can be a One-word or Word group OE type and an Erroneous or Inappropriate type.

^bThe terms "within-word disfluency" and "stuttering" are used interchangeably throughout this paper, regardless of whether these speech behaviors are produced by children who do or do not stutter. We consider the term "within-word disfluency" to be a relatively objective descriptor, and "stuttering" to be a more typically used, relatively subjective term (e.g., Zebrowski & Conture, 1989) for certain types of speech disfluencies.

element for "repair-stuttering" type clusters, and it was the overt repair or covert repair element for "repair-repair" type clusters. Speaking rates of the overt error and/or associated overt repair words were measured. These speaking rate measures were taken on all syllables preceding both the onset of a stuttering, which was the second element of interest for "repair-stuttering" type disfluency clusters (e.g., the bracketed segment in "[Fly to Ne—] t-t-to Peter Pan."), and the onset of a self-repair, which was the second element of interest for "repair-repair" type clusters. In "repair-repair" cases, the first overt error and/or repair words were measured, leading up to the onset of the overt error of a second overt repair (e.g., the bracketed segment in "[Mommy a par— car 'posed to come out] dow— out now.") or up to the onset of a covert repair (e.g., the bracketed segment in "[I'Kay this—] these ones-these ones go right here . . ."). The speaking rate analysis used by the present authors was similar to the measure of fluent or "articulatory speaking rate" (Kelly & Conture, 1992), but differed from it because the segments sampled in the present study may have included a cut-off portion, and such segments would not be considered to be completely fluent. All syllables produced in each measured segment were counted, and the number of syllables was divided by the duration of the segment in seconds and milliseconds, so as to yield a speaking rate in syllables per second (sps).

Sequences of disfluency cluster elements. According

to Bakeman and Gottman (1986), cluster elements met the basic criterion for sequential analysis, that is, as defined, they were mutually exclusive and exhaustive. Clusters were assessed in terms of the number of elements (i.e., length) as well as the type and sequence of elements. For example, the utterance "*I-I-I* [element 1]—*you were going* [element 2]" is 2 elements in length, and it is a "Stuttering (ST)-Overt Repair (OR)" type of cluster, hereafter described as a "ST-OR" sequence. To meet the criterion for assessment of "transitional probabilities" (i.e., the likelihood of a second successive behavior, given one behavior has occurred; Bakeman & Gottman, 1986, pp. 140–141), only 3-element clusters that contained the same two types of speech disfluencies in a sequence (e.g., OR-ST-ST clusters included in an OR-ST sequence—ignoring the second ST)³ could be considered for CWS and none could be considered for CWNS. That is, according to guidelines provided by Bakeman and Gottman (1986; p. 140), the minimum number of data points required for 3-element clusters was computed to be 118, and CWS met this number ($N = 137$), whereas CWNS did not ($N = 44$).

³Siegel (1956) recommends that the total number of sequences categorized = 9 and that where k = number of codes; L = length of sequences being considered, m = number of possible sequences when adjacent codes are different [$m = k(k - 1)^{L-1}$], and N_s = minimum number of sequences that need to be extracted from the data, the formula is: $N_s = 9m^2/m - 1$. For the present data, the minimum requirement for numbers of sequences is $k = 3$. Where $L = 2$, and $m = 6$, $N_s = 65$, but where $L = 3$ and $m = 12$, $N_s = 118$.

Comparison with disfluency cluster occurrence due to chance. To assess whether speech disfluencies were observed to occur in clusters greater than would be expected by chance, the observed percentages of clustered and single disfluencies were compared using expected percentages generated by a Monte Carlo simulation (Hubbard & Yairi, 1988; Silverman, 1973). A commercially available software package (SYSTAT; Wilkinson, 1990) was used to run a program that generated a variable x containing random uniform integers, and seeded by the number of words (300) and the number of disfluencies per subject. For comparing the observed to expected number of clusters, the following steps were taken: (a) the program generated a list of random numbers reflecting word positions in the 300-word transcript (e.g., 233 would signify the 233rd word); (b) the number of random numbers in the list was set equal to the number of disfluencies produced by each subject; (c) each subject's random number list was scanned in order to detect any replicated or adjacent numbers; and (d) the adjacent numbers were checked to make sure they did not cross utterance or finite clause boundaries. In this way, numbers of expected clusters were obtained, per subject and per group, so as to compare to numbers of observed clusters.

Between- and within-group comparisons. Bonferroni adjustments were used for all multiple comparisons, in which an overall alpha of 0.05 was divided by the number of comparisons. Nonparametric statistics were employed because the variables often lacked a normal (Gaussian) distribution and sometimes involved relatively small sample sizes (e.g., only 13 of the CWNS produced at least one cluster containing a covert repair and a stuttering for the purposes of testing the second hypothesis). Specifically, Mann-Whitney U tests (Siegel, 1956) were used to assess differences in measures (e.g., number of clusters) between talker groups because independent samples were being compared. Where frequency was so disparate between talker groups (e.g., stuttering frequency) that a Mann-Whitney U comparison yielded a $U = 0$, independent t -tests were used. Within-group relations and differences were assessed by means of Pearson product-moment correlations, and dependent t -tests. Dependent t -tests were used where sample sizes were sufficient and variability small enough to warrant assuming a normal (Gaussian) distribution. Within the CWS group, the following variables were compared to disfluency clusters: (a) chronological age; (b) stuttering frequency; (c) time since onset of stuttering; and (d) severity, as measured by the Stuttering Severity Instrument (Riley, 1981) overall scores; and, for the CWNS group: (a) chronological age; and (b) stuttering frequency.

Intra- and inter-judge measurement reliability. Six 300-word transcripts, 3 from each talker group, were randomly selected for re-judgment by the first author (i.e., *intrajudge*) and a graduate-level student in speech-language pathology (i.e., *interjudge*) who had been trained to code speech behaviors (i.e., disfluencies and overt errors) and clusters. The relatively conservative Cohen's (1960) Kappa statistic (which ranges from 0.00 to 1.00) was used for assessing agreement within and between observers because Kappa provides an index of proportion of agreement

after chance agreement is removed from consideration (e.g., Bakeman & Gottman, 1986; Hollenbeck, 1978).

Intrajudge measurement agreement across the 6 transcripts was "excellent" (Mean Kappas > 0.75) (Bakeman & Gottman, 1986; Fleiss, 1981) for the following measures: number of speech behaviors (Mean Kappa = 0.86; range = 0.76 to 0.95), type of speech behaviors (Mean Kappa = 0.91; range = 0.79 to 0.98), number of clusters (Mean Kappa = 0.93; range = 0.76 to 1.0), and cluster type and sequence (Mean Kappa = 0.97; range = 0.88 to 1.0). *Interjudge* measurement agreement was "good" (Mean Kappas = 0.60 to 0.75) to "excellent" (Mean Kappa > 0.75) for the following measures: number of speech behaviors (Mean Kappa = 0.77; range: 0.54 to 0.91), type of speech behaviors (Mean Kappa = 0.95; range: 0.92 to 0.97), number of clusters (Mean Kappa = 0.87; range = 0.62 to 1.0), and cluster type and sequence (Mean Kappa = 0.77; range = 0.51 to 1.0).

Because the third hypothesis involved speaking rate measurement of the overt error and/or overt repair syllables, mean *intra-* and *inter-judge* measurement error was assessed for the duration in milliseconds of the involved words or syllables for 20% of all opportunities. Mean *intrajudge* measurement error was ± 2.2 videoframes (range = 0 to 11 videoframes) or 73 msec (range = 0 to 367 msec), and mean *interjudge* measurement error was ± 2.5 videoframes (range = 0 to 20 videoframes) or 83 msec (range = 0 to 667 msec).

Results

Between- and Within-Group Differences

Number and nature of all speech disfluencies and errors. As can be seen in Table 2, the 30 CWS produced six types of cluster elements significantly more or less frequently than the 30 CWNS. First, as would be expected, CWS produced significantly more within-word disfluencies or "stutterings" ($t = -8.933$; $df = 29.5$; $p < 0.017$) per 100 words. CWS also produced significantly more ($U = 276.5$; $p < 0.017$) self-repairs than CWNS. CWS produced significantly more ($U = 234.0$; $p < 0.006$) phrase repetitions per 100 words than did the CWNS, and, more specifically, CWS produced a significantly greater ($U = 289.0$; $p < 0.0125$) percent of covert repairs that were phrase repetitions including a cutoff word (e.g., "and th—and then"). Finally, CWS produced a significantly greater ($U = 234.5$; $p < 0.0125$) percent of one-word overt errors (e.g., "you— did you say . . .") than did CWNS. However, compared to CWS, CWNS produced a significantly greater ($U = 641.0$; $p < 0.0125$) percent type of "Appropriate-Level" overt repairs (e.g., "I will put this little kid— little girl in there").

Observed versus expected number of disfluency clusters. As can be seen in Table 3, and as is consistent with Hubbard and Yairi's (1988) findings, the 30 CWS produced significantly ($U = 76.0$; $p < 0.05$) more disfluency clusters than CWNS. As can also be seen in Table 3, for CWS, there was no difference ($t = -0.844$; $df = 29$; $p < 0.05$) between numbers of disfluency clusters observed versus expected.

TABLE 2. Means (and standard errors) of the frequency of each cluster element type per 100 words produced by children who stutter (CWS) and children who do not stutter (CWNS). Types of overt errors (OEs), overt repairs (ORs), and covert repairs (CRs), are indicated as percentages (%) of each of these categories, excluding questionable types.

Cluster element types	CWS (N = 30)	CWNS (N = 30)
Total stutterings*	10.53 (1.10)	1.09 (0.10)
Total Overt Errors (OE)	11.60 (1.06)	11.10 (0.80)
One-word OEs (% total OE)*	47.6% (3.3%)	32.5% (2.8%)
Word-group OEs (% total OE)	47.1% (3.4%)	59.4% (3.2%)
Total Overt Repairs (OR)	9.90 (0.80)	9.10 (0.70)
Production-based ORs (% total OR)	42.6% (3.1%)	33.7% (4.6%)
Different message ORs (% total OR)	40.0% (3.2%)	34.5% (3.8%)
Appropriate level ORs (% total OR)*	11.6% (2.2%)	22.8% (2.9%)
"Repair-on-the-fly" ORs (% total OR)	1.0% (0.6%)	4.2% (1.8%)
Total Covert Repairs (CR)	4.70 (0.40)	3.10 (0.35)
Editing terms	6.57 (1.20)	4.40 (0.70)
Whole-word repetitions (nonstuttered)	3.30 (0.50)	1.87 (0.30)
Phrase repetitions (PR)*	1.57 (0.26)	0.68 (0.12)
PRs of entire words (% total CR)	20.0% (2.7%)	16.0% (3.2%)
PRs of cutoff words (% total CR)*	14.4% (2.4%)	7.0% (2.1%)
Total self-repairs (CR + OR)*	8.16 (0.70)	5.81 (0.40)

* $p < 0.017$.

However, for CWNS, a significant difference ($t = 5.168$; $df = 29$; $p < 0.05$) was found between number of disfluency clusters observed versus expected.

Observed versus expected percent clustered disfluencies per total disfluencies. Table 4 shows that there was a significantly greater percent clustered disfluencies per total disfluencies than would be expected by chance for both CWS ($t = 2.199$; $df = 29$; $p < 0.05$) and CWNS ($t = 6.624$; $df = 29$; $p < 0.05$), again supporting Hubbard and Yairi's (1988) findings.⁴

Disfluency cluster lengths and types. CWS produced significantly ($U = 210.5$; $p < 0.025$) more of their total disfluency clusters ($M = 46.0\%$; $SE = 3.37\%$) that were three-or-more elements in length than did CWNS ($M = 22.7\%$; $SE = 4.42\%$). Most importantly, however, and as displayed in Figure 1, about a third of the two-element disfluency clusters produced by CWS were Stuttering-Stuttering (SS) clusters ($M = 32.1\%$; $SE = 3.7\%$), whereas the CWNS talker group never (0) produced an SS cluster in any of their 30 300-word samples, a clearly significant and categorical between-group difference ($U = 45.0$; $p < 0.0125$). CWS also produced significantly more ($U = 287.0$; $p < 0.0125$) Stuttering-Repair (SR) clusters ($M = 20.2\%$; $SE = 3.0\%$) than CWNS ($M = 10.9\%$; $SE = 3.2\%$), but there was no difference ($U = 447.5$; $p > 0.0125$) between talker groups in production of Repair-Stuttering (RS) clusters. CWNS produced significantly ($U = 747.0$; $p < 0.0125$) more

Repair-Repair (RR) clusters ($M = 59.5\%$; $SE = 5.8\%$) than did the CWS ($M = 21.7\%$; $SE = 4.1\%$).

Correlations of within-group variables and disfluency clusters. As might be expected, stuttering frequency and severity of CWS were significantly and positively correlated with number of disfluency clusters ($r = 0.84$; $p < 0.0125$; $r = 0.75$; $p < 0.0125$, respectively). One significant positive correlation ($r = +0.586$; $p = 0.002$) was found between severity and "covert repair-stuttering" clusters (e.g., "Uh mmmmy girl has dots on her."). As also might be expected, in CWS, one significant positive correlation was found between Stuttering-Stuttering (SS) cluster frequency and stuttering frequency ($r = +0.596$; $p < 0.003$). Stuttering frequency was significantly and positively correlated ($r = +0.527$; $p < 0.025$) with number of disfluency clusters produced by CWNS, a finding that parallels that of CWS.

Cluster sequences of 2 elements exceeding chance occurrence. CWS met, but CWNS did not meet, the 118

TABLE 3. Means (and standard errors) for observed and expected numbers of speech disfluency clusters produced by children who stutter (CWS) and children who do not stutter (CWNS). As can be seen, two significant differences were found. Between-group comparisons were made using the Mann-Whitney U statistic, and within-group comparisons were made using dependent t -tests.

Talker groups	Number of clusters observed*	Number of clusters expected
CWS (N = 30)	13.0 (1.2)	13.5 (1.4)
CWNS (N = 30)**	4.6 (0.4)	2.9 (0.4)

* $U = 76.9$; $p < 0.05$

** $t = 5.168$; $df = 29$; $p < 0.05$

⁴The present findings of 64% and 49% observed clustered disfluencies in CWS and CWNS, respectively, is higher but reasonably comparable with the 57% and 34% reported by Hubbard and Yairi (1988) for CWS and CWNS, respectively.

TABLE 4. Observed and expected mean proportions of clustered and single disfluencies per total disfluencies for children who stutter (CWS) and children who do not stutter (CWNS). Both talker groups produced a significantly ($p < 0.05$) larger proportion of clustered disfluencies observed to cluster than was expected by chance. (The same is true for single disfluencies since it is a complement proportion.)

Talker groups	Clustered disfluencies observed*	Clustered disfluencies expected*	Single disfluencies observed*	Single disfluencies expected*
CWS (N = 30)	0.64	0.56	0.36	0.44
CWNS (N = 30)	0.49	0.26	0.51	0.74

* $p < 0.05$

minimum data point criterion, determined from the formula provided by Bakeman & Gottman (1986). As can be seen in Figure 2, for the 30 CWS, three sequences were found to significantly exceed chance levels: (a) a stuttering preceding an overt repair; (b) a stuttering preceding a covert repair; and (c) an overt repair preceding a stuttering.

Findings relative to 3 hypotheses under test. The 3 hypotheses tested and the statistical results are presented in Table 5. As can be seen in Table 5, the first two hypotheses were *not* supported in both talker groups, whereas the third hypothesis was supported only for the CWNS. In "repair-stuttering" clusters, CWNS produced overt error and/or repair (OE/OR) syllables at a significantly ($t = -2.309$; $df = 11$; $p < 0.05$) faster speaking rate ($M = 6.55$ sps; $SE = 1.4$ sps) than when these OE/OR syllables preceded other repairs in "repair-repair" type clusters. CWS, however, produced overt error and/or repair syllables at comparable speaking rates in both "repair-stuttering" and "repair-repair" clusters. Thus, a significant ($U = 125.5$; $p < 0.05$) between-talker group difference was found in terms of speaking rates at which OE/OR syllables are produced prior to stutterings in "repair-stuttering" clusters.

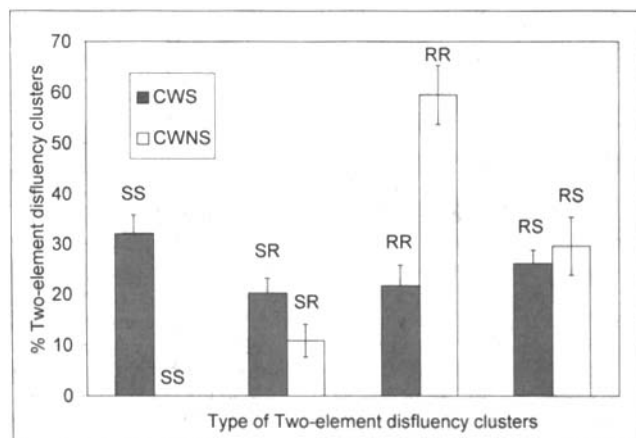


FIGURE 1. Four types of disfluency clusters produced by children who stutter (CWS) and children who do not stutter (CWNS): Stuttering-Stuttering (SS) (e.g., "I-I-I-I w-w-was"), Stuttering-Repair (SR) (e.g., "I w-w-was—I am going"), Repair-Repair (RR) (e.g., "I was—um I am going"), and Repair-Stuttering (RS) (e.g., "I was—I am g-g-going"). Each of the four cluster types are expressed in percent total two-element clusters, produced by CWS and CWNS. The first three types significantly differed between talker groups ($p < 0.0125$), and the fourth type (RS) did not.

Summary of results. CWS produced significantly more stutterings and self-repairs than CWNS, as would be expected. It was also found that CWS produced significantly more phrase repetitions (e.g., "and then—and then"), phrase repetitions including a cutoff word (e.g., "and th—and then"), and one-word overt errors (e.g., "you—did you say . . .") than did CWNS. However, CWNS produced significantly more "Appropriate-Level" overt repairs (e.g., "I will put this little kid—little girl in there") than did CWS.

The unique findings of the present study were those relating CRH tenets and terminology to disfluency clusters. Most importantly, about a third of the two-element disfluency clusters produced by CWS were Stuttering-Stuttering clusters, but none of the CWNS talker group produced them, yielding a categorical between-group difference. Conversely, CWNS produced significantly more Repair-Repair clusters than did CWS. CWS produced significantly more Stuttering-Repair clusters than CWNS, but there was no difference between talker groups in production of Repair-Stuttering clusters. The more severe the stuttering behavior of the CWS was rated, the more "covert repair-stuttering" clusters (e.g., "Uh mmmmy girl has dots on her.") the child produced.

Three sequences of disfluencies within clusters for the CWS were found to significantly exceed chance levels:

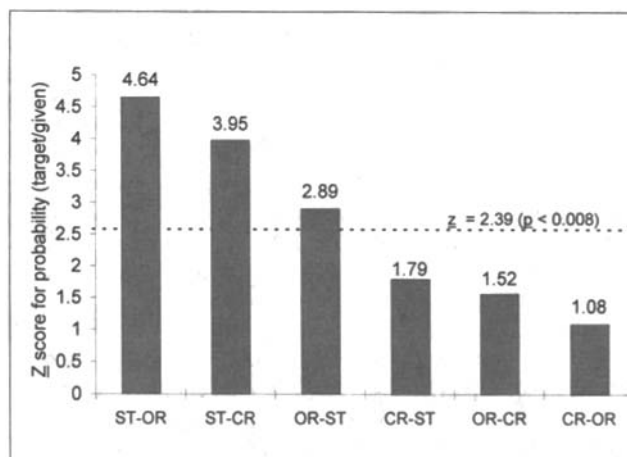


FIGURE 2. For children who stutter, three disfluency cluster sequences exceeded $z = 2.39$; $p < 0.008$ and thus were significant: Stutterings preceding Covert Repairs (ST-CR), Stutterings preceding Overt Repairs (ST-OR), and Overt Repairs preceding Stutterings (OR-ST).

TABLE 5. Results of testing the three hypotheses, displayed in means (and standard errors) for children who stutter (CWS) and children who do not stutter (CWNS). STs = stutterings; OEs = overt errors; CRs = covert repairs; ORs = overt repairs; Rs = repairs (CRs + ORs); OR-ST = overt repair-stuttering cluster; OR-R = overt repair-repair cluster; sps = syllables per second. Between-group comparisons were made using the Mann-Whitney *U* statistic, and within-group comparisons were made using dependent *t*-tests.

Hypotheses	CWS (<i>N</i> = 30)	CWNS (<i>N</i> = 30)	Between-group	Within-group
#1: STs are more likely to coincide with OEs than other words in the cluster.	STs/OEs coincide: 15.7% (2.5%) Ts/other words: 15.8% (2.2%)	STs/OEs coincide: 16.4% (4.7%) STs/other words: 30.6% (6.9%)	<i>U</i> = 434.0	CWS: <i>t</i> = -0.29 (<i>df</i> = 29) CWNS: <i>t</i> = -1.45 (<i>df</i> = 27)
#2: STs are more likely to coincide with CRs than other words in the cluster.	STs/CRs coincide: 60.4% (6.25) STs/other words: 39.6% (6.2%)	STs/CRs coincide: 53.8% (9.5%) STs/other words: 46.2% (9.5%)	<i>U</i> = 202.5	CWS: <i>t</i> = 1.684 (<i>df</i> = 29) CWNS: <i>t</i> = 0.267 (<i>df</i> = 12)
#3: The OE and/or OR syllables preceding STs are produced at faster speaking rates in OR-ST clusters than those preceding repairs in OR-R clusters.	OE/ORs preceding STs in OR-ST clusters: 3.22 sps (0.39 sps) OE/ORs preceding Rs in OR-R clusters: 3.93 sps (0.40 sps)	OE/ORs preceding STs in OR-ST clusters: 6.55 sps (1.40 sps) OE/ORs preceding Rs in OR-R clusters: 3.15 sps (0.27 sps)	OR-ST clusters: <i>U</i> = 125.5* OR-R clusters: <i>U</i> = 88.0	CWS: <i>t</i> = -1.05 (<i>df</i> = 18) CWNS: <i>t</i> = -2.309 (<i>df</i> = 11)*

**p* < 0.05

Stuttering-Overt Repair (ST-OR) clusters, Stuttering-Covert Repair (ST-CR) and Overt Repair-Stuttering (OR-ST) clusters. Finally, results of testing three hypotheses suggested the following: (a) stutterings are just as likely to occur on other words in disfluency clusters as they are to occur on overt errors; (b) stutterings are just as likely to occur on other words in disfluency clusters as they are to occur on covert repairs (and thus, presumably, covert errors); and, (c) in the talker group of CWNS, overt error and/or repair syllables produced at a faster speaking rate tended to precede stutterings.

Discussion

Comparison to Previous Research

Present findings regarding children's speech disfluencies and disfluency clusters can be compared to the findings of similar studies in several ways. Relative to speech disfluencies in general, the present finding that CWS produced two to three times more total speech disfluencies than CWNS is consistent with results of numerous other studies (e.g., Hubbard & Yairi, 1988; Johnson & Associates, 1959; Yairi & Lewis, 1984; Zebrowski, 1991). Further, finding that CWS produced significantly more phrase repetitions per 100 words of conversational speech is consistent with findings reported by Johnson and Associates (1959).

Relative to speech disfluency clusters, present findings corroborated two of Hubbard and Yairi's (1988) findings: (a) CWS produced significantly longer clusters than did CWNS; and (b) CWNS, but *not* CWS, produced significantly more clusters than would be expected by chance. However, present findings suggest that for CWS, particular sequences of disfluencies do occur significantly greater than would be expected by chance—ST-OR, ST-CR, and OR-ST.

Speech Disfluency Clusters: Explanations Relating to the Covert Repair Hypothesis

To our knowledge, this is the first empirical study that applies the Covert Repair Hypothesis (CRH) to a phenomenon of childhood stuttering—disfluency clustering—in attempts to account for the phenomenon. It will be recalled that one of the CRH's basic assumptions is that CWS have impaired (i.e., slower-to-activate) phonological encoding abilities. Although it is difficult to directly assess this assumption by means of a descriptive study such as ours, some support for this idea would seem to come from our finding that CWS are significantly slower than CWNS in selecting, encoding, and/or articulating the overt error and/or repair syllables prior to stutterings. Our finding significantly more one-word overt errors in CWS than in CWNS also seems to support this idea. Similarly, Wijnen and Boers (1994) found differences in the speech onset latencies during phonological priming tasks between adults who do (*N* = 9) and do not (*N* = 9) stutter, and suggested that temporal impairments or perturbations in phonological encoding are likely to be involved in stuttering.

One of the main purposes of the present study was to employ the CRH in attempts to account for *why* speech disfluencies cluster together. To do this, we started from the CRH assumption that stutterings are the by-products of self-repairing speech errors, and, in specific, of covertly self-repairing them. Thus, one of the more simple, straightforward conclusions about speech disfluency clusters, from the perspective of the CRH, is that stuttering-stuttering clusters merely reflect a series of covert errors and covert self-repairs. That is, stuttering-stuttering clusters may reflect little more than a period of speech production where there is a mismatch or lack of appropriate phase-locking between the child's rate of selection of speech units and his or her ability to encode and thus articulate them.

However, this relatively straightforward interpretation does not seem to readily account for our finding that fast

overt self-repair segments preceded stutterings in the speech of CWNS. Perhaps, the *overt* self-repair process that occurs on one sound, syllable, or word increases the chances that a subsequent word will be stuttered. Below, we will speculate about two such possibilities of how stutterings could be precipitated on subsequent words by (a) fast self-repairs and/or (b) delays created by self-repairs.

First, with regard to *fast* self-repairs leading to stuttering, it will be recalled that CWNS in the present study produced *overt* self-repair segments at significantly faster speaking rates preceding stuttered words. In fact, these children nearly doubled the speaking rate with which they produced *overt* self-repairs preceding other repairs (6.55 syllables per second [sps] versus 3.22 sps). Actually, 6.55 sps is more than twice the mean overall speaking rate of 3.14 sps for 3- to 5-year-old children reported by Amster and Starkweather (1987), and considerably above the range of means (3.72–4.33 sps) for articulatory speaking rate during spontaneous speech for 3- to 5-year-olds reported by Walker, Archibald, Cherniak, and Fish (1992). Perhaps, for CWNS, producing particularly rapid *overt* self-repairs reflects an increase in their rate of selection of speech units, an event that would increase the likelihood that they will mis-select sounds and syllables for immediately subsequent words, leading to self-repairs and then stutterings.

Second, *delays* due to *overt* self-repairing might lead to stutterings on subsequent words. According to the tenets of the activation-spreading model (e.g., Dell, 1986) and the covert repair hypothesis (e.g., Postma & Kolk, 1993), when children stop their speech productions or “cut themselves off” because they have detected an aspect of their speech to be inappropriate, some time must elapse—regardless of how brief—for the appropriate sound, syllable, or word to rise to a sufficient level of activation to be selected, encoded, and then articulated. In theory, therefore, because of this “necessary wait time,” if the child does not adjust his/her rate of selection to possible delays in the restarting of the phonological encoding process for subsequent speech units, mis-selections of subsequent speech units might occur. In essence, if the child does not maneuver his or her rate of selection according to circumstances and continues at the same speaking rate or even increases it for the subsequent word, the resulting *overt* self-repairs may increase his or her chances for mis-selecting subsequent speech units, which will result in more speech errors, self-repairs, and stutterings as by-products.

In either case, self-repairs on one sound, syllable, or word may produce, on immediately subsequent words, a disruption in “phase-locking” between the child’s rate of selection of speech units and his or her ability to phonologically encode. In the case of using a fast rate of self-repair, the child may select subsequent speech units at a rate faster than he or she is able to phonologically encode, thus leading to mis-selections of speech units for the subsequent sounds, increased speech errors, and so on. In the case of being delayed due to *overt* self-repairs, if the child does not adjust his or her rate of selection to accommodate to the temporary delay in phonological encoding that may result from self-repairing, he or she may mis-select speech units for the next words, with the same sequence of mis-selec-

tions or errors, repairs, and stutterings occurring. Whether one, both, or neither of these two possibilities operates in repair-stuttering clusters, we, of course, do not know. However, present findings strongly suggest that the production of self-repairs on preceding sounds, syllables, or words are not unrelated to stutterings on subsequent sounds, syllables, or words.

Extending the above speculations to the development of stuttering-stuttering clusters, a disfluency cluster type seemingly unique to CWS, it may be the case that at the onset of stuttering, *overt* self-repairs were produced frequently enough so as to disrupt the temporal relation between these children’s rate of selection of speech units and their ability to phonologically encode immediately subsequent words. And, if self-repairs on certain speech units could lead to stutterings on subsequent speech units, perhaps disruptions in phonological encoding and/or speaking rate brought about by stuttering, at least some of the time, might precipitate more stutterings on subsequent sounds, syllables, or words. This would not mean that repair-stuttering clusters would cease to exist for CWS once stuttering-stuttering clusters begin to be observed, but rather, that repair-stuttering clusters might be viewed as precipitating agents. That is, perhaps repair-stuttering clusters lead to repair-stuttering-stuttering clusters and then repair-stuttering clusters remain a residual part of the speech communication problem of CWS.

At this point, of course, we are not sure whether some self-repairs are more likely to be followed by stutterings than others. We did find, however, that the CWS produced significantly more phrase repetitions including within-word cut-offs (e.g., “*I want s—I want something*”) and relatively short (i.e., one-word) *overt* errors (e.g., “*the guy—man*”), whereas CWNS produced significantly more “Appropriate-level” (general-to-specific or specific-to-general) *overt* repairs (e.g., “*little kid—little girl*”). These findings seem compatible with those of Howell, Kadi-Hanfi, & Young (1991) who found that CWS (age 3:0–11:0) were less likely than CWNS to produce phones/syllables beyond the *overt* error. Such findings suggest that the internal speech monitoring processes of CWS may differ from those of CWNS. Obviously, a good deal more work is needed in this area before we can fully describe and account for disfluency clusters in the conversational speech of children who do and do not stutter, but it does appear that speech errors, self-repairs, or speech disfluencies on word(s) influence the occurrence of any of the same behaviors on subsequent words in a nonhappenstance and probably theoretically important fashion.

Alternative Explanations of Data

The CRH tenet that stutterings are the by-products of self-repairs leads us to be interested in the particular sequence of stutterings following self-repairs. Since discussion of present findings have only addressed how a preceding word might *influence* following words, relative to possible causation of speech disfluency clusters, it seems fair to note the converse. That is, preceding words may be *influenced* by following words. Cognitive, emotional,

speech, and/or language adjustments that an individual makes for an upcoming word may affect the words preceding it. That is, we have assumed, relative to speech disfluency clusters and given the sequence of Word 1 followed by Word 2, that speech errors, self-repairs, and speech disfluencies on Word 1 could lead to the same on Word 2. But, conversely, we could assume that speech errors, self-repairs, and speech disfluencies on Word 2 could lead to the same on Word 1, in the manner of anticipatory, regressive, or right-to-left assimilation that occurs with phonemes (e.g., Edwards & Shriberg, 1983; Ohde & Sharf, 1992). It is, of course, difficult to ascertain on the basis of this study where and how the influence of speech errors, self-repairs, or speech disfluencies "spreads" between adjacent speech units.

Two of the three disfluency cluster sequences that occurred significantly greater than chance in the sample of 30 CWS involved stutterings preceding self-repairs (both overt and covert). This finding that stutterings precede self-repairs suggests to us the possibility that stutterings could precipitate or "trigger" self-repairs. Perhaps the production of a stuttering creates disequilibrium in the child speech production system, creating phonemic or supra-phonemic errors. A related suggestion, first put forth by Fein (1970), is that stutterings of CWS may lead to stuttering-stuttering clusters by serving as "stimulus cues that elicit the responses of anxiety, physical tension and further stuttering" (Hubbard & Yairi, 1988, p. 232). Stutterings could elicit self-repairs as well as more stutterings; in fact, the present finding that the more severe the CWS, the more "covert repair-stuttering" clusters (e.g., "*Uh mmmmy girl has dots on her.*") he or she produced, suggests that covert repairs may precede and perhaps even be precipitated or "triggered" by the anticipation of upcoming stutterings.

Caveats and Future Research Directions

The relative paucity of research into young talkers' disfluency clusters (i.e., only Colburn, 1985; Hubbard & Yairi, 1988; Silverman, 1973) and the quite recent theoretical attempts to account for the relation of self-repairs to stutterings (Kolk, 1991; Kolk et al., 1991; Postma, 1991; Postma & Kolk, 1993) warrants at least two caveats about interpretation of the present findings and directions for future investigations.

First, large within-group variability was found, so much so that some apparent between-group differences were not found to be significantly different. In future research of children who stutter, the following methods might be used to reduce variability: (a) collect data from more subjects; (b) obtain larger speech samples per subject; and (c) employ different talker group criteria (e.g., assess only moderate and severe CWS). These methods may improve researchers' ability to empirically assess the sequencing of disfluency cluster elements produced by CWS, for example, children with mild stuttering compared to children with severe stuttering. A single-subject experimental design might also help overcome within-group variability and provide a way to explore the relation of stutterings to self-repairs.

Second, although many (in)dependent variables were ex-

amined by the present investigator, perhaps many just as important ones were not. Of the four independent within-group variables, time since onset (for the group of CWS) and chronological age (for both talker groups) failed to yield any significant results. This is perhaps not surprising, considering previous research involving time since onset and chronological age (Conture, Yaruss, & LaSalle, 1990; Enger, Hood, & Shulman, 1988; Yairi & Ambrose, 1992). Other variables may be more related to speech disfluency clustering. For example, Yaruss and Conture (1993) found that CWS at "low risk" for continuing to stutter produced consistently shorter F2 transitions in the iterations of the sound-syllable repetitions than the "high risk" group. They suggested that there may be some subsegmental lengthening or harbingers of segmental lengthening (i.e., sound prolongations) in the sound-syllable repetitions produced by the "high-risk" group. Thus, future researchers may want to acoustically assess selected sub-segmental aspects of stuttering-stuttering clusters. In specific, they may want to study the duration of F2 transitions in sound-syllable repetitions to determine whether changes in these sub-segmental parameters might further our ability to specify the relationship between stuttering-stuttering clusters and stuttering chronicity.

Conclusions

Findings of the present study appear to have both clinical and theoretical relevance. With regard to clinical implications, the finding that the frequency of disfluency clusters is correlated to the stuttering frequency and severity of CWS is consistent with diagnostic guidelines suggesting that children who produce more clusters are more apt to exhibit more severe, more chronic stuttering (Curlee et al., 1993). Likewise, there appears to be a good deal of clinical relevance in finding a categorical between-talker group difference for stuttering-stuttering (SS) clusters, that is, 32% of the total clusters produced by CWS were SS, versus 0% for CWNS. Perhaps, if a child whose parents believe to be "stuttering" produces relatively fluent speech on the day of an evaluation and yet produces even one or two SS cluster(s), such an observation may prevent the diagnostician from making an incorrect rejection or a "false negative" type of judgment error (see Conture, 1990a, pp. 10-13).

Of theoretical interest is finding that within disfluency clusters, stutterings did not coincide with overt, or, presumably, covert errors any more often than not, suggesting stutterings are not the speech errors themselves but by-products of the self-repair processes. Also, only in the CWNS talker group were overt error and/or repair syllables spoken at a fast rate more likely to precede, and thus perhaps precipitate, stutterings. These findings appear to lend support to the Covert Repair Hypothesis (CRH) (Postma & Kolk, 1993) and to the aforementioned possibilities about how a stuttering problem may begin and progress.

Onslow (1992) stated that etiological theories of stuttering have their "shortcomings in explanatory power (p. 984)," and it appears that the CRH of childhood stuttering (Kolk et al., 1991) is no exception. Kolk (1991) quite aptly stated that many etiological accounts of stuttering "are underspecified

with respect to the *immediate* causation of the stuttering event (p. 135)." Indeed, one major advantage of using the CRH as a means to explain disfluency clusters and many other stuttering phenomena (Kolk et al., 1991) is just that. The CRH, although clearly in need of further testing, especially with children who stutter, permits a reasonable degree of descriptive as well as experimental specification about possible *immediate* causation or precipitation of stutterings. Such specification, we believe, is needed if we are to continue to improve our theoretical understanding and treatment of children who stutter.

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