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The Influence of Voicing Adjustments on the Location of Stuttering in the Spontaneous Speech of Young Child Stutterers

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The spontaneous speech of nine young (4–6½ yr) male stutterers was recorded in 45-min play sessions. All subjects had stuttered for 6 mo or more and had been diagnosed as stutterers by experienced clinicians. Transcriptions of the tapes were marked to show where stuttering occurred relative to phonemic events. Stuttering occurred significantly more often on words for which voice was initiated after a pause—whether at the beginning or the middle of a sentence—than during running speech. In running speech, frequency of stuttering was influenced by the voicing feature of the sounds surrounding the stuttered phone.

INTRODUCTION

This study was designed to examine the voicing feature and its possible relationship to the location of stuttering in the spontaneous speech of young children. Previous researchers have focused on the difference in the frequency of stuttering between consonants and vowels, both for adults (Brown, 1945; Soderberg, 1962; Taylor, 1966), and for children (Williams, Silverman, and Kools, 1969). Following Wingate's (1969) review, in which he concluded that "vocalization is a crucial element in the complex of stuttering (1969, p. 685)" attention has turned to voicing adjustment as an important articulatory factor in stuttering. For example, Adams and Reis (1971, 1974) showed that stutterers adapted more

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rapidly when reading passages in which all the target sounds are voiced than when reading those in which both voiced and voiceless sounds occur. Starkweather, Hirschman, and Tannenbaum (1976) suggested that stutterers are slower in initiating phonation than are nonstutterers. At a physiological level, Freeman and Ushijima (1978) have found aberrations of laryngeal muscle activity associated with stuttering blocks.

All this work suggests that phonatory adjustment is in some way different for stutterers than for nonstutterers. However, the studies supporting this point of view have been done, in the main, with adult subjects, in whom stuttering behavior may have changed as it developed from its earliest form. Although considerable controversy surrounds the notion of developmental stages in stuttering (Bloodstein, 1975), if laryngeal adjustment is crucial, we should expect to find some evidence for this point of view in the loci of stuttering blocks in the spontaneous speech of children when they are first diagnosed as stutterers.

METHOD

Subjects

The subjects were nine male stutterers, aged 4.0–6.6. Each child had been diagnosed as a stutterer by an experienced clinician, had stuttered for 6 mo or more, and had expressed himself with a flow of language intelligible to the examiner. None of the subjects had known brain damage or learning disability.

Procedure

The spontaneous speech of each subject was recorded in a play session lasting approximately 45 min. The tapes were first transcribed into standard English orthography without notation of stuttering. All words were transcribed, including the voiced filler "uh," to ensure that all articulatory transitions were incorporated in the analysis (transcript 1). The speech samples ranged in size from 809 to 1780 words, with an average of 1275 words per subject. The first author then listened to the tapes a second time, marked stuttering instances, and computed the percentage of stuttered words (transcript 2). Criteria used to guide the assessment of stuttering instances were a modification of those listed by

Van Riper (1971, p. 74). The behaviors judged by him as stuttering instances were sound and syllable repetitions, prolonged sounds and prolonged articulatory postures with or without audible tension. As only audible cues to blocks were available, silent blocks were substituted for the last category. Van Riper lists the category of whole-word repetition, but because unforced repetition of words is common in young children, this category was omitted.

Mean rate of stuttering was 8.3% stuttered words per subject. It should be noted that stuttering never occurred more than once per word and, in all but two instances, the sound affected by stuttering was judged to be the first sound in the word. The two exceptional instances were dropped from the count. A second evaluation was carried out 1 mo after the first, and a Sander index of reliability was computed (Sander, 1961), resulting in a reliability coefficient of 0.93 between the two sets of judgments.

A third transcript was then made (transcript 3) on which pauses attributable to utterance boundaries or interruptions were marked as 0. The first sound of each word was then identified as being voiced (V) or voiceless (VL). The preceding sound—the last sound of the preceding word—and the following sound—the second sound of the word—were also identified as being voiced or voiceless. Thus, the initiation of each word was identified as belonging to one of 12 categories. The categories, along with a brief transcript with examples, are shown in Table 1. By comparing the second and third transcripts, it was possible to compute the percentage of stuttering for each of the 12 categories. The procedure for computing percentages was as follows. For each of the 12 categories, the frequency of the category and the frequency of stuttering within the category was computed. Thus, a subject who used category 11 100 times and stuttered 30 times on that category had a ratio of 30/100 or 0.30. He had 30 actual stutterings (AS) in 100 opportunities to stutter (OTS). The AS/OTS ratio was the measure used to determine the frequency with which stuttering occurred in the 12 categories.

RESULTS

Figure 1 shows the distribution of stuttering for the 12 categories for all subjects summed. Stuttering occurred at an average frequency of 19% for categories 1–4, in which word initiation followed a clause or sentence

TABLE 1
Text Sample with Categories

2 3 3 2 4 5
Wait ( )[a] him ( ) see? And ( ) I got

8 5 5 2 4
something with this. Like ( ) I

5 7 5 7 5 10 8
got the rest of this at home.

2 1 6 8 5 6 7 5 9
Yeah. Something has to be flat though or it

8 12 9 2 10 6 5 7
can't stand up. Yes I can get em

6 11 2 7 2 5 5
to stand. Like this? One is all

5 5 5 2 7 2 6
the way down like that. And how

6 9 7 8 9 10 6 10
come it don't fall if I put it

7 7 5 6 10 7 7 10 7
like and I put it like this it don't.

Examples of Category Types

Onset of utterance		
O-VL-V	Category 1	1 Yeah. Something
O-V	Category 2	1 This. Like
Onset after pause		
O-VL-V	Category 3	3 Wait ( ) him
O-V	Category 4	4 And ( ) I
Without preceding pause		
V-V-V	Category 5	5 I got
V-VL-V	Category 6	6 I put
VL-V-V	Category 7	7 flat through
VL-VL-V	Category 8	8 at home
V-V-VL	Category 9	9 stand up
VL-V-VL	Category 10	10 this at
V-VL-VL	Category 11	11 to stand
VL-VL-VL	Category 12	12 Can't stand

[a]Brackets indicate pause perceived within utterance.

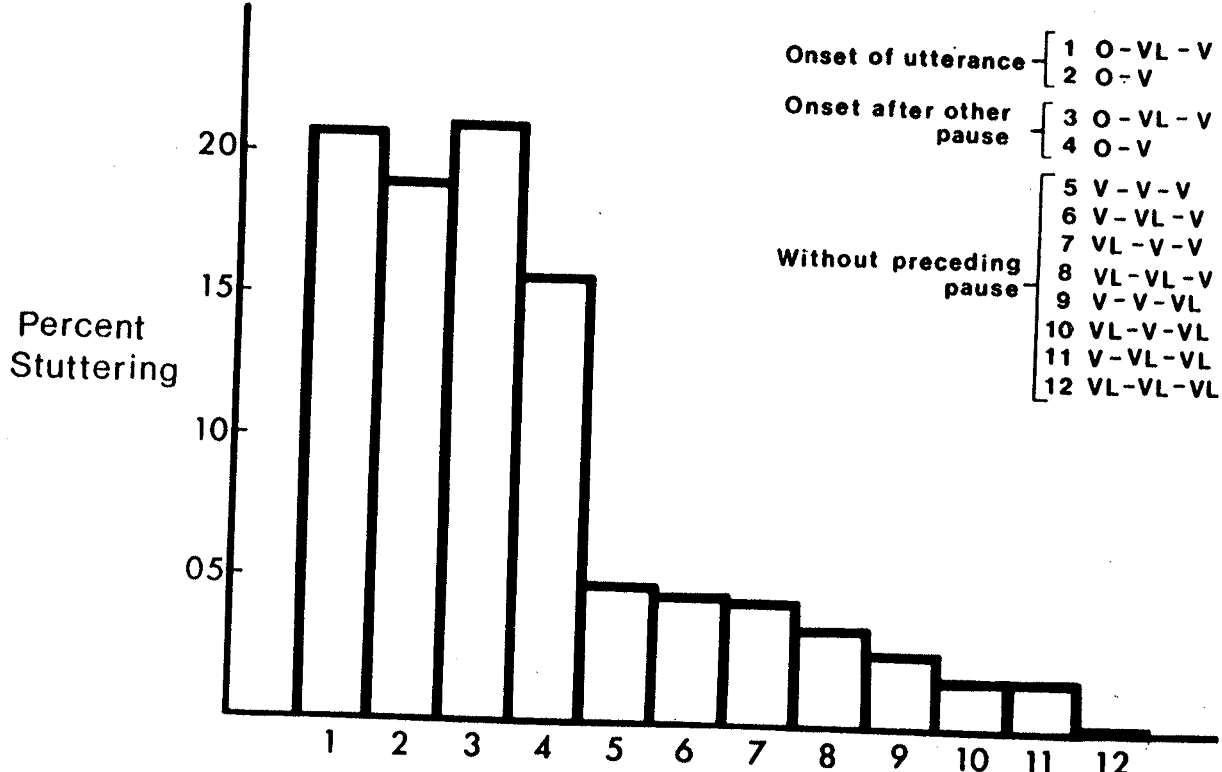

Figure 1: Stuttering for 12 voicing categories for all subjects.

boundary (categories 1 and 2) or a pause of some kind within an utterance (categories 3 and 4). Stuttering occurred fairly evenly among these four categories, whether the first sound of the word was voiced or voiceless.

Of words in categories 5–11, an average of 4.1% were stuttered. Category 12, in which a word beginning with a voiceless cluster followed a word ending in a voiceless phone, was the only category for which stuttering did not occur. Although category 12 was the least-used category, it did occur 31 times, providing ample opportunity for stuttering.

The sharp difference in the frequency of stuttering between categories 1–4 and 5–12 suggests the possibility that different factors are operating, one at the onset of speech, the other in "pauseless" connected speech. Because of this possibility, two two-way analyses of variance were computed (Roscoe, 1975), one for categories 1–4 and one for categories 5–12, to test for possible differences in the amount of stuttering for each of the two sets. The dependent variable for both analyses of variance was the rate of stuttering within each voicing category (AS/OTS). The independent variables were subjects and category membership (1–4 in the first analysis and 5–12 in the second analysis).

For categories 1–4, differences in the frequency of stuttering were not significant ($F = 0.9824$). In other words, given that a pause preceded a word, there was no evidence that the voicing status of word initiation influenced stuttering. Differences among the eight connected speech categories, however, were significant ($F = 5.8333$), indicating that category membership was related to stuttering frequency. For both analyses, there were significant differences among subjects.

The Scheffé test for all possible comparisons (Roscoe, 1975, pp. 313–315) was used to compare individual categories for categories 5–12. A critical d value of 0.046 was obtained. The results indicate that the differences between the following pairs of means were significant: 5>12, 6>12, 7>12, 5>11, 5>10, 5>9, 5>8.

The four most stuttered categories (categories 5–8) were found to share a common characteristic—in each case the word initiating sound was followed by a voiced sound. Conversely, the categories that were stuttered less (categories 9–12) share the characteristic of having the word-initiating sound followed by a voiceless sound. To test the hypothesis that the voicing feature of the second sound in the stuttered word determines the rate of stuttering, a Scheffé test for combined means (Roscoe, 1975, pp. 313–315) was computed. A composite mean for categories 5–8 was compared with a composite mean for categories 9–12, thereby testing directly to see if there was a significant difference in stuttering rate between sounds followed by voiced sounds and those followed by voiceless sounds. A significant difference was obtained, indicating that stuttering frequency is influenced by the voicing feature of the second sound of the stuttered word. However, as one examines the data category by category, it becomes clear that the percentage of stuttering decreases systematically, with categories containing all voiced sounds stuttered most often and categories that are entirely voiceless stuttered least.

In summary, stuttering was distributed unevenly among the 12 voicing categories. No stuttering occurred on the VL–VL–VL category where no voicing feature was present. Stuttering occurred more in categories 1–4, after a pause, than when voicing adjustments were made in connected speech. In categories 5–12, stuttering occurred with significantly greater frequency on words in which the second sound was voiced, regardless of whether the first sound was voiced or voiceless, than on words in which the second sound was voiceless.

A *post hoc* analysis of the data in categories 5–12 was carried out to determine whether the consonant/vowel distinction might be responsible for the significant difference in the frequency of stuttering between words for which the second sound was voiced and those for which it was voiceless. Using a random sampling procedure, the AS/OTS proportions of the stutterings were computed separately for those stutterings on which the sound following the word-initiating sound was a consonant and those for which it was a vowel. A Wilcoxon Matched-Pairs Signed Ranks Test was done to compare the frequency of stuttering in the two groups. No significant difference was found ($N = 6$, $T = 22$).

A further *post hoc* analysis was carried out to determine whether a significant difference in the rate of stuttering occurred on words beginning with consonants as opposed to words beginning with vowels, as was previously reported in the literature. The AS/OTS proportions of stuttered words were used from a random sample of the corpora. This was done for all stuttered words in the sample, regardless of which of the 12 categories they belonged to. The Wilcoxon Matched-Pairs Signed Ranks Test was used to compare the frequency of stutterings on words beginning with vowels with the frequency of stutterings on words beginning with consonants. No significant difference was found in the rate of stuttering between the two groups ($N = 9, T = 9$).

DISCUSSION

The results of this study support and extend previous findings in the literature, while failing to support others. The observation that stuttering tends to occur at the beginnings of sentences and clauses has often been made (see, for example, Quarrington, Conway, and Siegel, 1962), but usually for older subjects, in an analysis of read passages, although the same result is shown by Hejna (1955) for spontaneous speech in adolescent subjects. It is not clear from the observation alone, however, whether stuttering occurs following utterance and clause boundaries (1) because of their syntactic position, (2) because of their initiatory position, or (3) as an indirect consequence of either of these variables. The data presented here suggest that it is the initiatory position of the words following pauses, however generated, that is associated with stuttering. Although the "other pause" is far rarer than the clause-boundary pause, the likelihood that stuttering will follow is about the same. Syntactic variables are considered at greater length in the companion article to this one (*this issue*); but it seems appropriate to speculate about the role of behavior that often accompanies pausing in normal speech.

Typically, a pause in running speech will accompany inspiration. If we take the attitude that stuttering is an articulatory discoordination phenomenon of some sort (Perkins, Rudas, Johnson, and Bell, 1976), then we might presume that the time of occurrence of an inspiratory pulse is a particularly weak spot in the ongoing speech flow. Another reason why pause points might be particularly likely to generate stuttering is that they may be associated with breaks in the declination line, the tendency for fundamental frequency to drift downward through an utterance, to be reset at syntactic boundaries. Although investigations of this phenomenon are rather sketchy, it is believed that a speaker attempts to control the ramp so that it will coincide with a suitable syntactic unit (Pierrehumbert, 1979). Resetting might cause problems, as it involves laryngeal muscle reorganization. Another possible explanation is the changes in articulation rate that occur before and after pauses. Starkweather (1981) has reviewed studies showing that the rate of articulatory movement slows just before a pause, increasing immediately afterward. This rapid change in timing may precipitate stuttering.

Plausible explanations of the other findings of this study are somewhat harder to come by. The consonant/vowel analysis did not support previous research on adult subjects in which significantly more stuttering was found on words beginning with consonants, as opposed to vowels (Brown, 1945; Soderberg, 1962; Taylor, 1966). Also, this study did not support the findings of Williams, Silverman, and Kools (1969), who observed a similar distinction between consonants and vowels in children; however, the children in that study had a wider age range than did those in the present study. It is possible that the tendency to stutter on words beginning with consonants develops later, as it was not found in the young stutterers participating in this study.

The results for voicing are perhaps the most difficult to understand. Because there is an effect of the voicing characteristics of words on their probability of being stuttered, we have very general confirmation of the hypothesis that laryngeal adjustment is at the core of the stuttering block. The direction of the effects observed here, however, is puzzling. Adams and Reis (1971) suggested that it was the need for rapid on–off adjustments of voicing that might predispose toward stuttering. Here, the maintenance of voicing seems to generate more stuttering than does the maintenance of a nonvoiced condition.

Further explanations of the locus of the stuttering block, however, seem to depend on explorations of stuttering behavior at acoustic and physiological levels. The role of respiration should be checked by direct observation using the noninvasive techniques now becoming readily available. With respect to laryngeal adjustment variables, we need to concentrate on developing techniques that will inform us about the status of the laryngeal aperture during running speech, whether inferred from acoustic measures or arrived at more directly.

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