Winner of the 1997 Isabel Richard Award for Most Outstanding Student Paper / Récipiendaire du Prix Isabel Richard (1997) pour le meilleur mémoire étudiant

Extent and Stability of Stuttering Reduction During Choral Reading

Portée et stabilité de la réduction du bégaiement pendant la récitation en chœur

by • par

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ABSTRACT

An *ABA* time series design was used to examine the extent and stability of stuttering reduction during extended exposure to choral reading. Twelve people who stutter participated (*M* = 37 years). Group results showed a mean stuttering reduction of 94.2% during choral reading relative to reading alone, supporting the findings of previous, albeit dated, research that reported stuttering to be virtually eliminated during choral reading. With respect to individual data, all 12 participants exhibited marked reductions in stuttering frequency during choral reading (range of reduction: 77.6-99.7%), with no participant exhibiting more than 1.6% stuttering during choral reading. In addition, both group and individual results showed that stuttering reduction remained stable over 15 minutes of continuous choral reading. With respect to speech rate, group data yielded a statistically significant increase in global speech rate during choral reading relative to reading alone. However, individual participants varied with respect to degree and direction of change in global speech rate exhibited during choral reading compared to baseline performance. Consideration of fluent speech rate in combination with global speech rate indicated that decreased rate may have confounded the effect of choral reading for four participants. Present data for choral reading were compared to data from a similar study examining the effectiveness and stability of stuttering reduction during frequency altered feedback (FAF). Suggestions for future research are provided.

ABRÉGÉ

Un schéma séries chronologiques *ABA* a été utilisé pour étudier la portée et la stabilité de la réduction du bégaiement suite à une exposition prolongée à la récitation en chœur. Douze bègues ont participé à l'étude (x = 37 ans). Les résultats du groupe ont fait état d'une réduction moyenne du bégaiement de l'ordre de 94,2 % pendant la récitation, par rapport aux résultats de lecture individuelle, ce qui appuie les conclusions de recherches antérieures, et plutôt anciennes, qui signalaient la disparition presque totale du bégaiement lors d'une récitation en chœur. Pour ce qui est des données individuelles, les 12 participants ont exhibé des réductions notables de la fréquence du bégaiement pendant la récitation (fourchette de 77,6 à 99,7 %), aucun participant n'exhibant un bégaiement supérieur à 1,6 % pendant la récitation. En outre, les résultats pour le groupe et les particuliers montrent que la réduction du bégaiement est demeurée stable pendant les 15 minutes d'une récitation soutenue. Pour ce qui est du débit de parole, les données de groupe ont démontré une augmentation statistiquement significative de l'ensemble du débit de parole pendant la récitation en chœur, comparativement à la lecture individuelle. Toutefois, les résultats individuels des participants ont varié par rapport au degré et à la direction du changement de l'ensemble du débit de parole relevé lors de la récitation, comparativement au rendement de référence. La pondération combinée du débit de parole fluide et de l'ensemble du débit de parole a montré que le débit moindre peut avoir confondu l'effet de la récitation chez quatre participants. Les données présentes de récitation en chœur ont été comparées à celles d'une étude semblable qui examinait l'efficacité et la stabilité de la réduction du bégaiement pendant la rétroaction à fréquences modifiées. Des suggestions de recherches ultérieures sont offertes.

KEY WORDS
stuttering reduction • choral reading

Choral reading (also referred to as choral speech), the simultaneous oral reading of material by two or more people, has been reported to be highly effective in reducing stuttering. Based on a review of numerous studies of stuttering, Andrews et al. (1983) stated that choral reading is one of seven conditions that immediately eliminates stuttering. According to these authors, the immediate reduction in the frequency of stuttering is estimated to be 90-100%.

Much of the information regarding the effect of choral reading on stuttering frequency is provided by studies conducted more than four decades ago. Johnson and Rosen (1937) conducted the first serious experiment dealing with choral speech. These researchers had 18 participants orally read 15 different 500-word passages in 13 different reading conditions: In twelve of the conditions, participants used a prescribed speech pattern different from their usual

pattern, and in one condition participants used their typical speech pattern. Participants' use of their typical speech pattern served as the control condition of the experiment; they read three of the 15 different passages in this manner. Two of the twelve different reading conditions were choral reading conditions, one of which included a person who stuttered reading in unison with another person who stuttered and the second involved a person who stuttered reading in unison with a normal speaker. These choral reading conditions occurred late in the sequence of presented trials; they were two of the last three conditions presented, the last being a control condition. Group results indicated that in both choral reading conditions, only one word was stuttered; the percent of words stuttered was .01. Seventeen of the 18 participants did not stutter at all, and all 18 participants stuttered less than in ordinary reading conditions. It is important to note that participants in this study were instructed to read passages consecutively and that as a general rule decreased stutterings tend to occur with repeated consecutive readings of the same material, an effect known as adaptation (see Bloodstein [1995] for a review of adaptation studies). Since the choral reading conditions appeared late in the experiment, adaptation may have confounded these results, although the authors attempted to control for it by using different reading passages in each condition. Evidence that adaptation did occur is provided by comparison of control conditions where the participants read in their ordinary way during the 1st, 8th and 15th reading trials. Stutterings decreased from 7.6% during Reading #1 to 3.5% during Reading #15. Therefore, the adaptation effect may have contributed to the reduction in stuttering that occurred during choral reading.

However, a study by Bloodstein (1950) also suggested that choral reading is relatively unique in its power to reduce stuttering. Fifty participants who stuttered were interviewed regarding their stuttering frequency in approximately 115 situations. As each item was presented, the participants were instructed to rate their stuttering in that situation on a scale from 1-4, with 1 signifying as much stuttering as usual, or more, and 4 signifying no stuttering at all. Participants were instructed not to rate their stuttering in any situation(s) they had never experienced. Interestingly, the only situations in which all participants indicated that they had either very markedly less or hardly any stuttering, or no stuttering at all, were the situations of 'singing' and 'reading aloud in unison with others who are reading the same material'.

Choral reading has also been shown to be effective in reducing stuttering under stressful speaking conditions. For example, Pattie and Knight (1944) found dramatic eductions in stuttering during choral reading in the presence of an audience. The 12 participants in their study were required to read orally in six situations, four of which involved choral reading, and two of which were control conditions, where the participants read alone. During all four choral reading conditions, participants were required to read to an audience of 4-5 people. In two of the choral reading conditions, the accompanist was in the same room as the participant. In one of these two conditions, identical material was read by both people. In the second condition, different material was read by each person. During the remaining two conditions of choral reading, the accompanist's speech was conveyed to the stutterer by telephone. Again, identical material was used in one condition, while different reading material was employed during the second condition. Results of this study showed that stuttering was substantially reduced during choral reading of the same material, even when the accompanist was not in the same room as the stutterer. During unison reading of the same material, participants' stuttering reduced, on average, by 88% when the accompanist was in the same room as the participants, and reduced by approximately 87% when the accompanist spoke to them via a telephone. Eisenson and Wells (1942) also conducted a study that assessed frequency of stuttering during stressful speaking situations. The 19 participants in this study were required to read in unison with a familiar accompanist during two oral readings. Participants were told that the first reading was a rehearsal, while during the second reading, their speech would be directed to a room where an audience was listening. Seven of the 19 participants stuttered less during the stressful speaking situation and four participants exhibited the same amount of stuttering during both reading conditions. Results indicated that there was no statistically significant difference in stuttering episodes between the two conditions of choral reading.

The effectiveness of choral reading in reducing stuttering frequency as a function of the characteristics of the accompanist(s) and the reading material has also been examined. Johnson and Rosen (1937) illustrated that choral reading is equally effective regardless of whether the accompanying speaker is a stutterer or a normal speaker. Barber (1939) provided further evidence to support this finding. In addition, she showed that during choral reading, stuttering is reduced when the reading material is the same and when the material differs, although less reduction occurs when the material differs. Barber had 18 participants read 14 different passages under 14 different solo and choral reading conditions. These conditions included reading the same or different material and speaking simultaneously with stutterers or with 'normal' speakers, to name a few. Group results of this study indicated that stuttering was reduced by 90.7-97.8%

when both the participants (people who stuttered) and the accompanist(s) read identical material. The four conditions that markedly reduced stuttering were: a condition in which two stutterers and a normal speaker read with the participant (mean stuttering reduction of 97.8%); a condition where two stutterers read the same material as the participant (mean stuttering reduction of 95.1%); a further condition that involved simultaneous reading of the same material by a normal speaker and the participant (mean stuttering reduction of 92.7%); a condition where a stutterer and the participant read the same material (mean stuttering reduction of 90.7%). However, when reading different material, participants stuttered, on average, about 50% less, regardless of whether the accompanist was a stutterer or a normal speaker. It would be interesting to evaluate individual responses to each of these conditions to determine if individual people differ in terms of patterns of responses, but only group results were provided. The adaptation effect was also a concern in Barber's study as it may have contributed to an inflation in stuttering reduction during choral reading. It was measured through two control conditions in which the participant read alone, one as the first condition and the other as the last condition. Barber determined that for the group, there was a reduction in stuttering of 29.6% from the first control condition to the last control condition. Individually, three of the 18 participants did not show an adaptation effect: Two participants exhibited an increase in stuttering rather than the expected decrease and one participant produced the same number of stuttering blocks during both control readings.

Barber (1939) illustrated that with respect to potential factors influencing fluency enhancement during choral reading, the characteristics of the accompanist seem to be less salient than factors relating to the stimulus material being read. Pattie and Knight (1944) also examined a stimulus material effect in their study dealing with choral reading to an audience. In two of the four choral reading conditions, participants were required to read the same material as the accompanist, and in two conditions, different reading material was used. Results indicated that when identical material was read by the participants and the accompanist, stuttering was dramatically reduced. Despite the presence of an audience, participants exhibited a mean reduction of approximately 88% in number of stuttering episodes produced during choral reading of the same material, as compared to a control condition of solo reading. When the reading material differed, an average reduction of approximately 55% was noted in stuttering frequency.

Cherry and Sayers (1956) also examined the effects of choral reading when the stimulus reading material for each participant was the same and when the material differed. Results of this study differed from those of Barber (1939) and Pattie and Knight (1944). Cherry and Sayers noted that stuttering was not only greatly reduced during choral reading of the same material, but also during reading of differing material; when the accompanist changed his reading to a different paragraph of text, the participants "continued to read without stammering through the original paragraph" (Cherry & Sayers, 1956, p. 235). Cherry and Sayers also reported that stuttering was inhibited in all cases and on all occasions during choral reading by a stutterer and an accompanist who was speaking "gibberish" or nonsense words. In addition, they noted that choral reading by a stutterer and a tape recording of reversed speech could also produce similar findings with respect to reductions in stuttering frequency. However, caution is warranted when interpreting Cherry and Sayer's results. In presenting their data regarding stuttering frequency during choral reading, they provided no numerical results. They did not describe how many participants they used in each condition of choral reading or how many stuttering episodes were exhibited by each participant.

In terms of the studies presented thus far, participants, as a group, exhibited elimination or near elimination of stuttering frequency when reading the same material as an accompanist. As such, it could be postulated that dramatic reductions in stuttering during choral reading of the same material occurs universally for people who stutter. However, more recent data obtained by Ingham and associates (Ingham & Carroll, 1977; Ingham & Packman, 1979) suggested that the amount of stuttering reduction during choral reading may be less, and more variable across people, than originally suggested. Not all participants in these two investigations exhibited near elimination of stuttering during conditions of choral reading in which participants and accompanist read the same material. For example, in the study by Ingham and Packman, while the choral reading condition produced more than a 90% reduction in stuttering for two of the three participants, it yielded only a 56% reduction in stuttering for the third participant of the study. Ingham and Carroll reported an average reduction of 84% in stuttering frequency during choral reading across the nine participants who took part in their study. Further, Ingham and Carroll reported that only three out of 18 five-minute recordings made during conditions of choral reading did not contain any instances of stuttering.

One explanation for the discrepancy between many of the older studies and those by Ingham and associates may be related to methodological problems associated with the older studies. The results of some of these studies were apparently confounded by the adaptation effect. That is,

stuttering decreased during the course of the experiment regardless of the condition under which participants were speaking. For example, in Johnson and Rosen's (1937) experiment, stuttering was decreased by more than 50% in ordinary solo reading. As such, it is difficult to meaningfully interpret reductions under choral reading: While stuttering was essentially eliminated for most participants during choral reading, it is possible that the adaptation effect contributed partially to this large reduction. The studies by Ingham and his colleagues attempted to control for adaptation, and thus, their data may be more accurate. In both studies, participants were instructed to read on seven different occasions. Four occasions (two choral reading conditions and two solo reading conditions) required oral reading of one passage (Passage A), and three occasions (solo reading only) required oral reading of a different passage (Passage B). Passage B was read between each of the four readings of Passage A to help control for any adaptation effects. In addition, all reading occasions were separated by a two-minute break interval. Ingham and Carroll (1977) did not find an adaptation effect, as results indicated that stuttering frequency did not decrease across readings of Passage B.

Interestingly, a study by Andrews, Howie, Dozsa, and Guitar (1982) that also carefully controlled for adaptation, found that stuttering was virtually eliminated during choral reading, a finding that is similar to those of the older studies mentioned previously. In Andrews et al., stuttering frequency for three participants was assessed during six baseline conditions and 15 different speaking conditions, one of which was choral reading. This choral reading condition involved the participant reading from a newspaper in unison with two fluent speakers. The design of this study was a repeated AB design, whereby repeated baseline trials took place between each experimental condition. These repeated baseline trials were conducted until stuttering frequency returned to a value within the range established in the six original baseline conditions. The only fluency enhancing condition presented in this study that totally eliminated stuttering was choral reading. All three participants exhibited no stuttering during this condition. However, of primary concern is the fact that only three participants were studied. Due to this limited sample of participants, it is difficult to make conclusions about the effectiveness of choral reading with regard to the general population of people who stutter. Therefore, further study is warranted to determine the extent of stuttering reduction during choral reading for a larger number of participants.

In addition to determining the overall effectiveness of choral reading in reducing stuttering frequency, further study is needed to assess the consistency of stuttering reduction over time and across individual participants. To date, studies assessing stuttering reduction during choral reading have reported the effect as a single number: percent reduction in stuttering, typically reported as a group mean. For the most part, studies have used brief periods of choral reading consisting of a single reading of a 500-word passage. Exceptions are the studies by Ingham and his associates in which participants were required to read numerous passages of five-minute duration. Nevertheless, stuttering frequency was reported in terms of a single number, representing the data collapsed both across time and participants. To our knowledge, there have been no studies that have assessed the stability of choral reading over time and the consistency of both short and long term effects across participants. The research reviewed suggested that choral reading may have a very powerful immediate effect on stuttering, but the extent to which the reduction is maintained over a longer time period is unknown. The beneficial effect of this fluency enhancing condition may deteriorate across readings of numerous passages and/or long term effects may be variable across persons who stutter.

Evidence that marked stuttering reduction occurs during short samples but can deteriorate over extended durations has been demonstrated for another fluency enhancing technique: frequency altered feedback (FAF). Kalinowski and colleagues (Hargrave, Kalinowski, Stuart, Armson, & Jones, 1994; Kalinowski, Armson, Roland-Mieszkowski, Stuart, & Gracco, 1993; Stuart, Kalinowski, Armson, Stenstrom, & Jones, 1996) have reported powerful effects of FAF in reducing stuttering frequency. In a review of studies of fluency enhancement, Armson, Kalinowski, and Stuart (1995) reported that during FAF, participants reduced stuttering frequency, on average, by 80-90% during the reading of a single 300-syllable passage in experimental versus control conditions. However, stuttering reductions during longer exposure to FAF have not been as substantial. Armson and Stuart (1998) tracked stuttering frequency over one-minute intervals for two five-minute baseline conditions and a 10-minute FAF condition during reading and monologue tasks. Graphical representation of stuttering frequency group means for the reading task revealed that the effects of FAF were not stable; that is, there was a notable increase in frequency of stuttering over the 10 minutes of FAF (i.e., stuttering increased from approximately 3% at the beginning of FAF to about 10% at the end of 10 minutes of FAF). Furthermore, with respect to individual participants' data, considerable variation in patterns was exhibited. Armson and Stuart found that during the reading task, three of their twelve participants exhibited a classic treatment effect, wherein a large reduction in stuttering was experienced

following the initial baseline condition and a return to baseline was noted after the treatment condition was removed. Six participants showed a substantial reduction in stuttering frequency with the introduction of the treatment condition of FAF, but demonstrated a return to baseline values during the experimental condition. The remaining three participants showed little change in stuttering frequency during the experimental condition of FAF relative to the two baseline conditions. Similar findings regarding inconsistent effects of FAF across persons who stutter and over extended periods of speech were reported by Ingham, Moglia, Frank, Ingham, and Cordes (1997). Ingham et al. found that during a reading task, three of four participants exhibited a reduction in stuttering under FAF, but for one of the three, the effect occurred primarily during the initial phase of the condition. Therefore, because individuals' patterns and degree of stuttering reduction during extended exposure to FAF differ, the dramatic group mean reductions in stuttering noted during short exposure to FAF may not be representative of the long term effect and do not reveal individual differences in response to FAF. It is questioned whether the effects of choral reading are comparable to the effects of FAF. That is, is stuttering reduction stable during extended exposure to choral reading? In addition, it is of interest to know how individual patterns of response compare to one another. Therefore, it is important to determine profiles of individual responses throughout longer exposure to choral reading, in addition to obtaining a total percentage of reduction in stuttering.

In summary, there are two main purposes of the present study. The first is to investigate the overall effectiveness of choral reading in reducing stuttering across a relatively large number of participants, assessing both individual responses as well as a group response. The second purpose of the current study is to investigate the stability of fluency enhancement during choral reading over time, particularly with respect to examining individual profiles of stuttering reduction during choral reading relative to baseline conditions.

Method

Participants

Twelve people who stutter (10 males, two females) participated in this study. Participants ranged in age from 16 to 51 years (M = 37 years, SD = 10.54). Eleven of the twelve participants had normal bilateral hearing as determined by a standard hearing screening performed within 12 months of participation in this study (normal hearing being defined as having thresholds of 25dB or better at octave frequencies between 500 - 4000 Hz). One participant had normal hearing at all frequencies except 500 Hz in his left ear, at which his threshold was borderline normal. Participants had no speech and/or language problem other than stuttering. Participants were recruited from a local hearing and speech clinic and a self-help group for people who stutter. Two participants were currently receiving therapy at the time of the study, eight people had received therapy in the past (more than one year before participation in the study) and two participants had never received therapy. Participants' severity of stuttering varied; to be included in this study, participants had to stutter, on average, on at least 3% of syllables in solo reading of a 300-syllable passage.

Equipment and Materials

Equipment. All testing was conducted in a sound-treated audiometric test suite. Participants spoke into a microphone (JVC Model M-510) that was situated approximately 15 cm from the participants' mouths. The participants' microphone output was fed to an audiomixer (Studiomaster Model Session Mix) and an amplifier (Sansui Model AU-55900), each of which was located in an adjacent test suite. An accompanist, who was located in the adjacent suite, also spoke into a microphone (Tie-Clip Microphone Cat. No. 33-1063). Binaural insert earphones (Ear Tone Model 3A) were used to deliver the speech of the accompanist to the participants. Participants' speech samples (during solo and choral reading) were recorded using a video camera (JVC Model S-62U) and a video cassette recorder (JVC Model BR-6400U).

Materials. Thirty-five passages, each of which was slightly more than 300 syllables in length, were presented to the participants for oral reading. These passages were extracted from four junior high level texts in social studies and science (Sims, 1987a, 1987b; Taylor, 1985; Vogt, 1995).

Procedure

An *ABA* time series design, involving solo and choral reading conditions was used. Specifically, participants read alone continuously for 10 minutes at the beginning and the end of the experiment. Between the two 10-minute baseline conditions, they read continuously with the accompanist for 15 minutes. Before initiation of the experiment, the loudness of the accompanist's speech was set to comfortable listening levels for each participant. The accompanist, the first author, is a normal speaker. During choral reading, the accompanist attempted to assume the lead role. That is, participants were asked to begin reading with the accompanist when requested to do so and to follow the pace she set. The pace was set at an acceptable reading rate for each participant; if difficulties with speak-

ing rate arose, adjustments in pace were made accordingly. Participants were instructed to continuously read the set of 35 reading passages. Participants were instructed not to stop reading between passages within each of the conditions (two baseline conditions and one experimental condition). After each condition, participants took a brief break, and then reading resumed with the next passage in sequence. If participants exhibited hesitation while reading orally, or did not read in synchrony with the accompanist, the accompanist spoke more slowly to allow the participants to "catch up". Participants were required to wear the insert earphones for all three conditions. During the choral reading condition, participants only heard the speech of the accompanist through the insert earphones; that is, participants did not hear their own speech output through the earphones. Participants were instructed not to use any strategies or techniques to reduce their stuttering that they may have learned in therapy. Total testing time was approximately 50 minutes.

Speech Analysis

Stuttering count. A graduate student in speech-language pathology (the first author) counted stuttering episodes in the speech samples of each participant during playback of audio video recordings. Episodes were recorded on transcripts of the reading passages. The student had previous experience in counting stutterings and had been trained by a clinician with over 20 years of experience working with people who stutter. Stuttering episodes were defined as whole word repetitions, part-word repetitions, part-word prolongations, and inaudible postural fixations (i.e., "silent blocks"). Following identification of stutterings, the total number of stuttering episodes were tallied for each one-minute interval in each of the baseline and experimental conditions for each participant.

For purposes of reliability calculations, the first author performed a second count of stuttering episodes and the second author also counted instances of stuttering for ten percent of the total speech samples. Speech samples from the baseline conditions only were used in counts made for reliability purposes, to maximize the probability of stuttering being exhibited. Samples were compared syllable-by-syllable and number of agreements and disagreements were tallied. Calculations of percent agreement (i.e., number of agreements ÷ total number of syllables x 100) indicated that intrajudge agreement was 98.9% and interjudge agreement was 96.8%. To account for the contributions of chance agreement, Cohen's *kappa* analyses (Cohen, 1960) were performed. Intrajudge syllable-by-syllable agreement, as indexed by Cohen's *kappa*, was .94, while interjudge syllable-by-syllable agreement, as indexed by Cohen's *kappa* was .78. Both of these values indicate excellent agreement beyond chance (Landis & Koch, 1977a).

Global speech rate. The total number of syllables produced were counted for each one-minute interval in each baseline condition and the experimental condition. Only those syllables that occurred in real words were counted. That is, reiterated syllables produced during stuttering events were omitted from the count. However, one minute intervals were timed disregarding whether the speech produced was stuttered or fluent. Therefore, global speech rate is a measure that includes time spent stuttering. Calculation of syllables produced in each one-minute interval of speech which may include stuttering yielded a measure of global speech rate in terms of syllables per minute.

Fluent speech rate. To assess fluent speech rate (or articulatory rate) during baseline and experimental conditions, fluent speech samples were extracted. Identification of a sample of fluent speech was attempted for each one-minute interval of the baseline and experimental conditions. Only one fluent speech sample was identified per one-minute interval and no samples of fluent speech overlapped two intervals. Each fluent speech sample was required to contain at least 40 contiguous fluent syllables. Forty syllables was selected as a criterion for fluent speech samples to minimize the number of speech "start ups" and to ensure obtaining a relatively long section of naturally produced running speech. Each sample was separated from a stuttering episode by at least one syllable. Fluent speech samples were separated from stuttering episodes because it has been shown that syllable production is longer in duration when it is next to a stuttering episode than when it is adjacent to fluent speech (Viswanath, 1986).

No segments of 40 fluent syllables could be obtained during the two baseline conditions for five participants due to their high stuttering frequency. Therefore, fluent speech rate was calculated for only seven participants. Further, while fluent speech samples were identified during each of the 15 one-minute intervals of the experimental condition of choral reading for the seven participants, typically, 10 samples of fluent speech were not available for the baseline conditions. The number of fluent speech samples extracted from the first baseline condition ranged from 2-10, while the number of samples extracted from the second baseline condition ranged from three to eight.

Once a sample of 40 or more syllables was identified, the sample duration, in seconds, was determined. Timing of fluent speech samples was accomplished through use of a counter on the video cassette recorder, which provided timings to the nearest second. Timing of each fluent speech sample began with the first fluent syllable of the sample, and ended with the last fluent syllable. Because each fluent speech sample was less than one minute in

duration, fluent speech rate was calculated in terms of syllables per second.

Results

Group Data

Group means were calculated for the total number of stutterings and the total number of syllables produced during each one-minute interval in the three reading conditions. Figure 1 shows these values as a function of time. As illustrated in the graph, group results show a classic treatment effect for both number of stuttering episodes and number of syllables spoken. With respect to stuttering frequency, a marked decrease occurred during the 15 minutes of choral reading as compared to the first baseline condition, and then a return to baseline values occurred during the last 10 minutes of the experiment. No values in either of the two baseline conditions overlapped with values in the experimental condition. While the total number of stutterings decreased, the total number of syllables spoken increased dramatically during the experimental condition of choral reading relative to the two baseline conditions. Figure 1 also shows that during choral reading, mean stuttering reduction for the twelve participants was relatively stable over time.

Figure 1. Mean number of stuttering episodes (open squares) and syllables produced (filled circles) calculated for each of 35 consecutive one-minute intervals of oral reading (n=12). Vertical lines separate the first and last 10-minute baseline conditions from the 15-minute choral reading experimental condition.

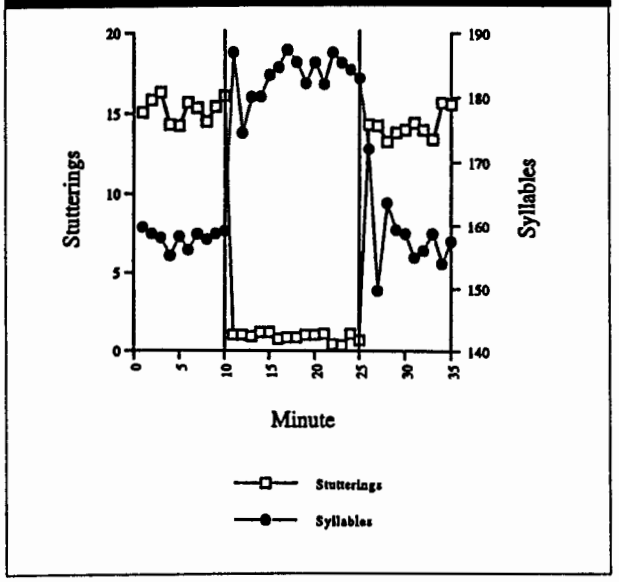


Table 1. Group Means and Standard Deviations for Each of the Three Dependent Variables.

Dependent Variable	Baseline 1		Choral Reading		Baseline 2	
	M	*SD*	*M*	*SD*	*M*	*SD*
Number of Stuttering Episodes	15.28	8.37	0.88	0.84	14.27	7.82
Number of Syllables Produced	158.04	60.90	183.47	21.74	158.27	59.57
Percent Stuttering	14.03	13.91	0.50	0.49	12.57	11.23

Table 2. Summary of Single-df Orthogonal Planned Comparisons Assessing Mean Differences Between Baseline Conditions and Baseline vs. Experimental Conditions.

Source	Baseline 1 vs. Baseline 2		Baseline vs. Experimental	
	F	*p*	*F*	*p*
Number of Stuttering Episodes	2.35	.15	74.20	0.0001
Number of Syllables Produced	0.00	.97	6.54	0.0179
Percent Stuttering	1.83	.20	25.03	0.0001

Note: df for all planned comparisons were 1, 11.

Data for each of the dependent variables, those being number of stuttering episodes, number of syllables produced and percent stuttering (number of stuttering episodes ÷ number of syllables produced x 100), were averaged across the 10 one-minute intervals for the two baseline conditions and across the 15 one-minute intervals for the experimental condition. Table 1 presents a summary of group means and standard deviations for each dependent variable. For each dependent variable, two orthogonal single-*df* planned comparisons (Keppel, 1991) were performed. One assessed the mean difference between the two baseline conditions and the second investigated the difference between the combined baseline conditions and the experimental condition. The means were weighted to account for the difference in numbers of observations between the baseline conditions and the experimental condition (10 vs. 15, respectively). Table 2 presents a summary of these findings. The alpha level was set at .05.

As is illustrated in Table 2, there were no statistically significant differences between the first and second base-

line conditions for number of stuttering episodes, number of syllables produced, and percent stuttering. In terms of the comparisons between the combined baseline conditions and the experimental condition, there were statistically significant differences noted with respect to all three dependent variables. The number of stuttering episodes decreased, the number of syllables increased and percent stuttering decreased during the choral reading condition relative to the two baseline conditions. In terms of percent stuttering, the mean amount of reduction during the choral reading condition relative to the two baseline conditions combined was 94.2%.

To statistically examine the stability of stuttering reduction across the experimental condition of choral reading, the 15 minute segment of choral reading was divided into three sections, each of which was five minutes in duration. This procedure was completed for each of the three dependent variables. The means for each section of the experimental condition were tested for differences using an analysis of variance (ANOVA) general linear procedure. With respect to all three dependent variables, there were no statistically significant differences found across values throughout the experimental condition of choral reading: number of stuttering episodes [$F(2,35) = 1.41$, $p = .26$], number of syllables produced [$F(2,35) = 1.29$, $p = .30$], and percent stuttering [$F(2,35) = 1.55$, $p = .24$].

Figure 2. Number of stuttering episodes (open squares) and syllables produced (filled circles) in each of 35 consecutive one-minute intervals of oral reading for participants 1-4. Vertical lines separate the first and last 10-minute baseline conditions from the 15-minute choral reading experimental condition. Note: The ordinate scales vary between graphs.

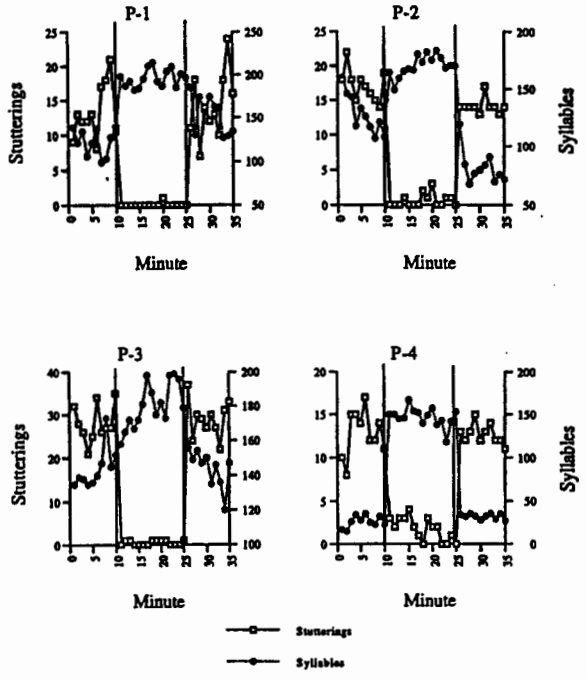
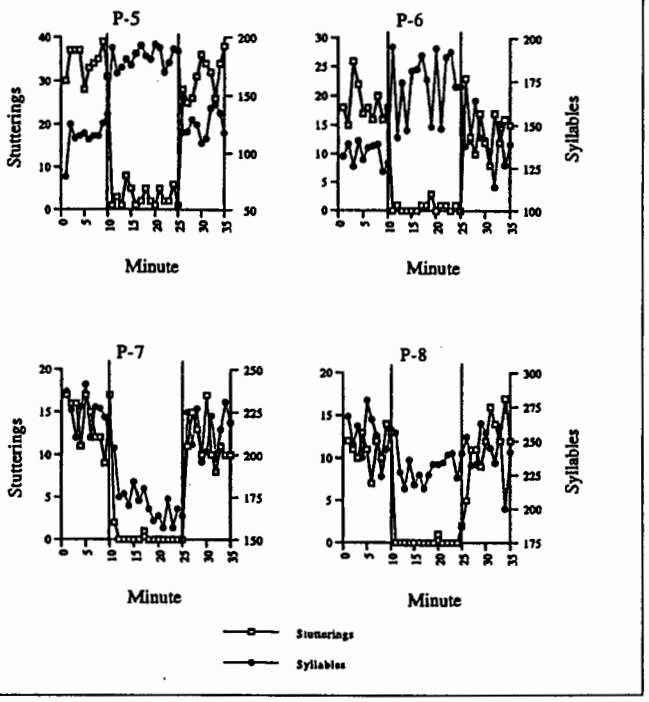


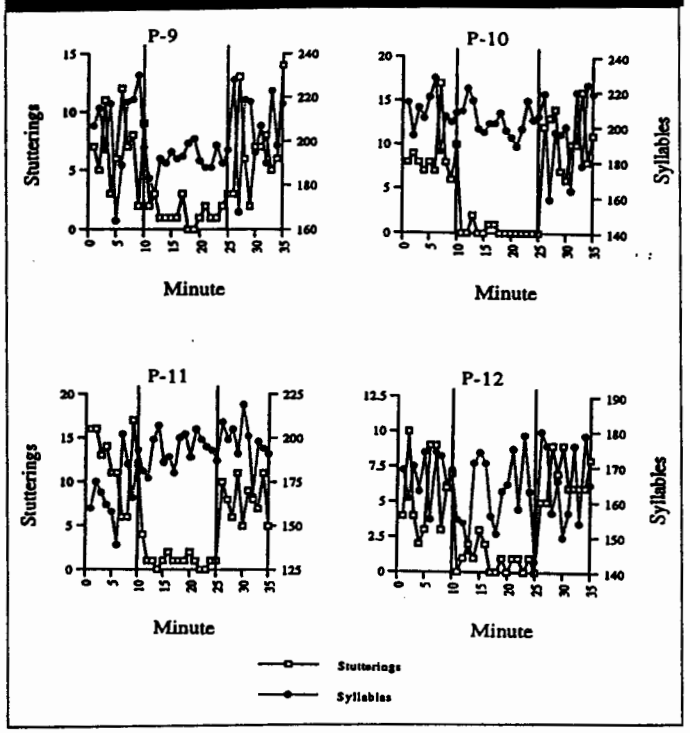
Figure 3. Number of stuttering episodes (open squares) and syllables produced (filled circles) in each of 35 consecutive one-minute intervals of oral reading for participants 5-8. Vertical lines separate the first and last 10-minute baseline conditions from the 15-minute choral reading experimental condition. Note: The ordinate scales vary between graphs.



Individual Data

Figures 2, 3, and 4 show the number of stuttering episodes and the number of syllables produced in each baseline and experimental condition for individual participants. Inspection of patterns for stuttering episodes showed that all 12 participants exhibited a clear treatment effect, that is, substantial reduction in stuttering during the 15 minutes of choral reading as compared to the first and last baseline conditions of reading alone. Participants' percent stuttering reduction ranged from 77.6% to 99.7% across the 15 one-minute intervals of the experimental condition relative to baseline performance (i.e., the two baseline conditions combined). However, four of the 12 participants (P-4, P-5, P-9 and P-12) exhibited more variability in the number of stuttering episodes produced during choral reading than the other eight participants. These participants did not demonstrate as consistent a "floor ef-

Figure 4. Number of stuttering episodes (open squares) and syllables produced (filled circles) in each of 35 consecutive one-minute intervals of oral reading for participants 9-12. Vertical lines separate the first and last 10-minute baseline conditions from the 15-minute choral reading experimental condition. Note: The ordinate scales vary between graphs.

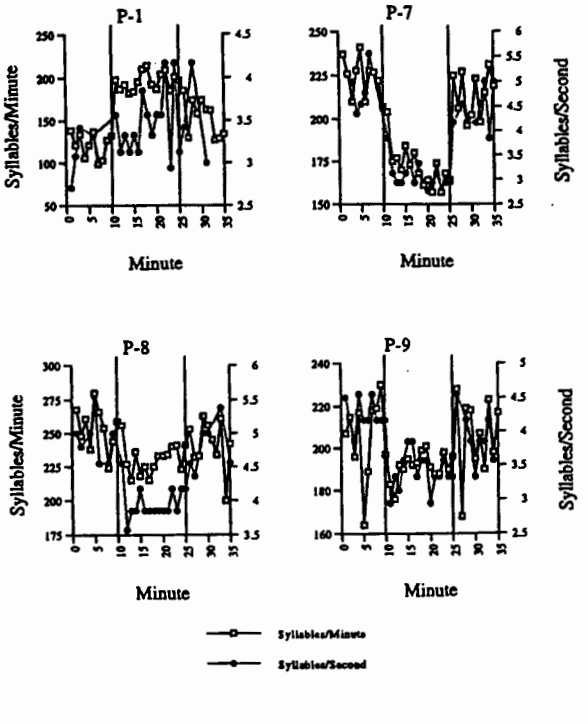


fect" during the experimental condition as the remaining eight participants. In addition, for two of these four participants (P-9 and P-12) a small number of the data points for stuttering episodes during choral reading overlapped with the data points for the baseline conditions.

Inspection of trends for number of syllables produced showed even more variability across participants than did trends for number of stuttering episodes. In terms of the number of syllables spoken, six participants, P-1, P-2, P-3, P-4, P-5, and P-6, exhibited the expected outcome, that being an increase in number of syllables spoken during the experimental condition of choral reading. One participant, P-7, clearly produced fewer syllables during the experimental condition than during the two baseline conditions, and five participants, P-8, P-9, P-10, P-11 and P-12, displayed no marked difference in syllable production during the experimental condition relative to either of the two baseline conditions. That is, these last five participants exhibited values in the baseline conditions that overlapped considerably with values in the experimental condition. As well, there was substantial variability in the number of syllables spoken within each condition for each of these five people. As such, no clear or consistent patterns could be identified.

Because 6 of the 12 participants who took part in this study did not exhibit the expected outcome of an increase in global syllable rate during choral reading, fluent speech rate was examined. The possible influence of reduced speech rate in contributing to stuttering reduction was considered a potential confound for these six people. Thus, analyses of fluent speech rate were performed to investigate the possible contribution of slowed speech rate to reducing stuttering frequency in this study. Figures 5 and 6 show comparisons in global speech rate and fluent speech rate for the data of the seven participants for whom fluent speech samples could be extracted. Fluent speech rate was plotted across the one-minute intervals in each of the two baseline conditions and the experimental condition for each of the seven people. Five of these seven participants were the five participants who exhibited no marked difference in global syllable rate during choral reading relative to the two baseline conditions of reading alone, one participant had showed a clear reduction in number of syllables produced during choral reading compared to the

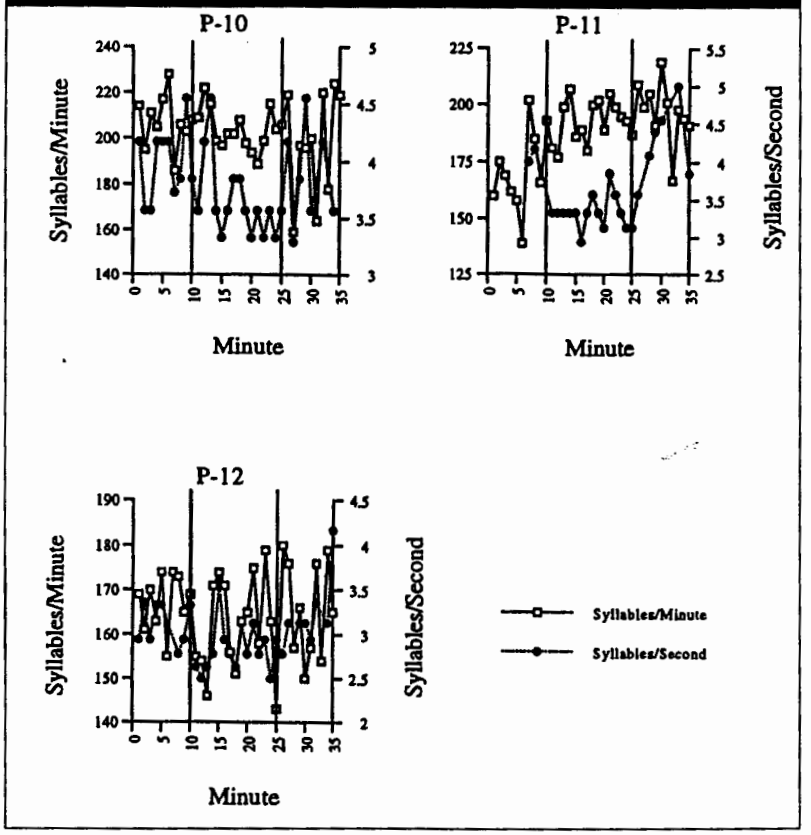
Figure 5. Comparison of global speech rate in syllables per minute (open squares) and fluent speech rate in syllables per second (filled circles) for participants 1, 7, 8, and 9. Vertical lines separate the first and last 10-minute baseline conditions from the 15-minute choral reading experimental condition. Note: The ordinate scales vary between graphs.



baseline conditions, and only one person was from the group of six participants who demonstrated the anticipated outcome in global speech rate, that is, an increase in the number of syllables spoken during choral reading.

Inspection of Figures 5 and 6 reveals that four of the seven participants, P-1, P-7, P-10, and P-12, exhibited similar trends of syllable production for both global and fluent speech rates during the baseline and experimental conditions. Participant-1 exhibited an increase in global syllable rate during choral reading relative to the baseline conditions. Similarly, P-1 demonstrated an increase in fluent speech rate during the latter portion of the experimental condition relative to the majority of values in the baseline conditions. Participant-7 displayed a clear decrease in number of syllables produced during the experimental condition as compared to the two baseline conditions for both global and fluent speech rates, and Participants 10 and 12 demonstrated marked variability in syllable production during all three conditions for both analyses of speech rate. The remaining three participants, (P-8, P-9 and P-11), displayed differing patterns of syllable production for global and fluent speech rates during the three conditions. With respect to global speech rate, these three participants exhibited variability in number of syllables produced during all three conditions and there was no substantial difference in syllable production during choral reading relative to reading alone. However, for fluent speech rate these participants exhibited a clear decrease in number of syllables produced during choral reading relative to the two baseline conditions.

Figure 6. Comparison of global speech rate in syllables per minute (open squares) and fluent speech rate in syllables per second (filled circles) for participants 10, 11, and 12. Vertical lines separate the first and last 10-minute baseline conditions from the 15-minute choral reading experimental condition. Note: the ordinate scales vary between graphs.



Discussion

Evidence for Marked, Stable Reductions in Stuttering During Choral Reading

With respect to group results, there are two principal findings in the present study:

1. Choral reading was extremely effective in reducing mean stuttering frequency for the twelve participants who took part. The mean reduction of 94.2% shows near elimination of stuttering for the group and falls within the estimated 90-100% reduction reported by Andrews et al. (1983). As a group, participants exhibited a mean of only 0.50% stuttering during choral reading, with a standard deviation of 0.49%.

2. The effectiveness of choral reading was stable over time. Group results showed a dramatic decrease in stuttering frequency at the onset of choral reading that remained consistent over the entire 15 minutes of the experimental condition. There was no statistically significant difference in frequency of stuttering across the three five-minute segments of the experimental condition.

With respect to individual responses to choral reading, all participants exhibited reductions in stuttering during the experimental condition. However, there was some variability across participants in amount of reduction. Nine of the 12 participants exhibited between 90-100% reductions in stuttering frequency during choral reading relative to reading alone. The amount of stuttering reduction demonstrated by these nine participants during choral reading ranged from 94.0-99.7%, illustrating elimination or near elimination of stuttering by these people. These nine participants exhibited less than 2% stuttering during choral reading (i.e., 0.03-1.64% of syllables produced in that condition were stuttered). The remaining three participants, although demonstrating substantial

reductions, exhibited less than 90% reductions in stuttering frequency during the experimental condition relative to the two baseline conditions. These participants' reductions in stuttering ranged from 77.6-89.5% during the experimental condition relative to the two baseline conditions. However, it is important to note that these three participants also demonstrated extremely low percentages of stuttering during choral reading: less than 1%. Therefore, absolute values of stuttering frequency during choral reading were comparable with those exhibited by the group of nine participants previously described. As such, in describing the effects of choral reading, it appears that determining an absolute value of stuttering frequency may be equally as important as obtaining an overall percent reduction in stuttering frequency. These two measures provide complementary information and together, they give a more complete picture than only one measure alone.

Inspection of the stability of stuttering reduction of individual participants during choral reading showed that the majority of participants exhibited stable reductions in stuttering during choral reading relative to baseline conditions. That is, for most participants, stuttering frequency throughout choral reading remained substantially lower than during the two baseline conditions of reading alone. Notably, eight participants displayed relatively consistent, "flat" patterns of stuttering frequency during choral reading (e.g., one participant, P-1, exhibited a range of 0-0.53% in stuttering frequency during choral reading). It should be noted, however, that two of the remaining four participants did exhibit a minimal number of values during the choral reading condition that overlapped with values displayed during baseline conditions.

Taken together, both group and individual findings suggest that choral reading is a powerful fluency-enhancing condition across people who stutter. Individual participants in this study demonstrated a range of percent stuttering reduction from 77.6% to 99.7% during choral reading relative to two baseline conditions. However, regardless of percent stuttering reduction, all participants exhibited very low percentages of stuttering during the choral reading condition: less than 2%. In addition, reductions in stuttering remained relatively consistent over the 15 minutes of the experimental condition, indicating the effects of choral reading are stable over extended durations. Each participant exhibited no more than 3.9% fluctuation in percent stuttering during choral reading.

Possible Confounding Variables

Speech rate. Speech rate was also examined in the present study. It was expected that as stuttering frequency decreased, global speech rate would increase. Global speech rate should increase because as frequency of stuttering decreases the amount of time spent stuttering also decreases, given that stuttering episodes take time. Therefore, since less time is spent stuttering, more syllables per minute can be produced, resulting in an increase in global speech rate. However, results of the present study indicated that only 6 of the 12 participants exhibited the expected increase in global speech rate during choral reading as compared to reading alone. Closer inspection of patterns of global speech rate showed that three different patterns were exhibited by participants. While six participants demonstrated an increase in global speech rate during choral reading, one participant exhibited a distinct decrease in global speech rate during the experimental condition relative to the two baseline conditions and five participants showed no substantial difference in global speech rate during choral reading relative to reading alone. Nevertheless, all 12 participants exhibited marked reductions in stuttering frequency during choral reading. As stuttering frequency was dramatically reduced for all 12 participants, but six of these people did not exhibit the anticipated increase in global speech rate, the issue of speech rate was a concern. The possibility that articulatory, or fluent, speech rate decreased during choral reading relative to the baseline conditions was considered. A decrease in fluent speech rate would be problematic because slow articulatory rate is known to be fluency enhancing (Andrews et al., 1982; Johnson & Rosen, 1937). Therefore, it was of interest in the present study to calculate fluent speech rate to determine if it could have been a confounding variable for the six participants who did not increase their global speech rate during choral reading. Calculation of fluent speech rate revealed that for the six participants for whom speech rate was considered a possible confounding variable, four did, in fact, decrease their articulatory rate during choral reading as compared to reading alone. As such, for at least four participants in the present study, the possible influence of reduced articulatory rate as a contributing factor to fluency enhancement cannot be disregarded. On the other hand, slowed articulatory rate probably did not contribute to stuttering reduction during choral reading for most of the remaining participants, given their marked increase in global speech rate in that condition.

The contributions of speech rate to stuttering frequency during choral reading has received minimal consideration in previous research. In describing choral reading conditions, many studies state only that participants were required to read in unison with one or more speaker(s) who were reading the material aloud with the participants. The accompanist(s) usually set the pace of the reading. The present study essentially followed this method of presen-

tation of the choral reading condition. Most older studies have not measured speech rate as a separate variable during conditions of choral reading. Exceptions are studies by Ingham and Carroll (1977), Ingham and Packman (1979), and Adams and Ramig (1980). All three studies were designed to test the claim made by Wingate (1969, 1976) that stuttering reduction during choral reading results from speech rate reduction. Results obtained by Ingham and colleagues may be interpreted as contradicting this claim, in part because participants in their studies exhibited reductions in stuttering frequency in association with increases in global speech rate. Adams and Ramig also failed to support Wingate's claim; they found that participants' speech during choral reading was not associated with an increase in the duration of speech segments, namely vowels.

The findings of the foregoing three studies provide support for the previous conclusion that reduction in stuttering frequency occurs regardless of reduction in speech rate. However, one method to explicitly examine the effect of speech rate on amount of stuttering during choral reading would be to perform an experiment in which participants are required to speak at an unusually fast rate of speech, as was used by Kalinowski and colleagues (Hargrave et al., 1994; Stuart et al., 1996) in studies investigating stuttering reduction during FAF. Use of a fast speaking rate would control for the possibility that slow rate of speech contributes to reduction in stuttering frequency. In addition to the suggestion mentioned above, various other methods can be employed to reduce the possibility that speech rate is acting as a confounding variable during conditions of choral reading. A possible improvement in the present study using a "live" choral reading condition that could have helped control for speech rate would be to calibrate the accompanist's rate of speech relative to a target rate. This calibration could be accomplished through timed practice of speaking aloud. Using a tape recording of the accompanist's speech is a second possibility for controlling for speech rate differences; using this method ensures that the accompanist uses the same pace or rate of speech with each participant. One possible technique involving tape recordings is a method such as that employed by Ingham and Packman (1979). Ingham and Packman made tape recordings of an accompanist's speech to be used during simultaneous reading of the participant and the accompanist during the choral reading conditions. These recordings of speech were produced based on each participant's stutter-free oral reading rate. That is, one week prior to participation in the study, each participant orally read alone one of the passages to be used in the study. From a recording of this reading, 36 groups of 5-6 fluent word sequences were identified and timed, thereby giving a stutter-free oral reading rate. An accompanist then orally read the same passage, at the pace of the participant's fluent reading rate. This reading by the accompanist was recorded and later presented to the participant during the experiment. One potential difficulty with this method, however, involves the possibility that a participant may speak unusually slowly during baseline conditions of fluent speech, if, for example, the participant had used the method of reduced speech rate during therapy to decrease stuttering frequency. A second difficulty that may arise in using recorded speech samples involves the synchrony of speech between participants and the accompanist. If participants fall behind in their speech, it may be more difficult for them to resume synchrony of speech with a recording. Through the use of a live accompanist, adjustments can be made by the accompanist when participants encounter difficulties. For example, slight pauses in speech allow participants to catch up if they experience a disfluency. To summarize, it is suggested that speech rate be controlled for during choral reading, as it is important that participants do not reduce their speaking rate. There are both positive and negative aspects to using live versus recorded accompaniment, and modifications to either may reduce or eliminate the confounding effect of rate of speech on the results.

Use of insert earphones. Participants were required to wear insert earphones during all three conditions in this study. Although this procedure maintained consistency throughout the experiment, the possible influence of the use of these earphones in contributing to reductions in stuttering must be addressed. Participants may have experienced an "occlusion effect" during the experiment, in which their own voice appeared louder to themselves than it actually was. This effect is noted when the ears are occluded in some way (e.g., when wearing earphones). When people experience an occlusion effect, some low frequency speech sounds that normally are passed out of the ear canal are instead reflected back into the canal, resulting in the perception of increased intensity of these sounds (Gelfand, 1990). In the present study, there is a possibility that during choral reading, the occlusion effect may have interacted with the effects of choral reading to reduce stuttering frequency. The extent, if any, to which the occlusion effect contributed to stuttering reduction for the participants in this study is unknown; however the possibility does exist. A method that could be used to control for the possible influence of an occlusion effect would involve a choral reading condition in which the accompanist was in the same room as the participant; in this situation, both the accompanist and the participant would read in unison and no earphones would be required; thus, the potential of an occlusion effect would not be of

concern.

Theoretical and Clinical Relevance of Present Findings

Theoretical relevance. According to past and present findings, people who stutter may be expected to experience minimal stuttering frequency during choral reading. However, while we know that substantial reduction in stuttering occurs during choral reading, we do not know why it occurs. Clearly, understanding why stuttering is reduced under conditions such as choral reading would help us to better understand the nature of the disorder and how it may be most effectively treated.

In the past, most attempts to learn something about the processes underlying temporary stuttering reduction have focused on the notion that all conditions of fluency enhancement are characterized by a specific speech pattern. For example, Wingate (1969, 1976) proposed that extended duration of speech sounds is the primary agent of temporary (or artificial) stuttering reduction underlying such conditions as choral reading, delayed auditory feedback, masking, and others. However, research findings have not provided support for Wingate's proposal. On the contrary, studies have shown that extended sound or syllable durations do not necessarily accompany temporary stuttering reduction (e.g., Adams & Ramig, 1980; Andrews et al., 1982) and that stuttering is markedly reduced under altered auditory feedback at fast and normal rates of speech (e.g., Kalinowski et al., 1993).

Subsequently Armson et al. (1995) proposed that there may be three categories of fluency enhancement conditions, only one of which is characterized by particular speech pattern features. The other two categories proposed consist of conditions associated with changes in speech input (versus output) and conditions associated with positive speaking-related cognitions. These authors postulated that each category of conditions may be associated with different underlying processes of fluency enhancement, a notion they supported by suggesting that the characteristics of induced fluent speech differ across the three categories. For example, it was argued that fluent speech under conditions of speech output alterations is neither natural-sounding nor stable across difficult speaking situations, whereas under conditions involving positive speaking related cognitions, fluent speech is natural-sounding but not stable in difficult situations, and under conditions involving speech input alterations, it is both natural-sounding and stable in difficult situations.

While not directly testing the above proposal specifically, the present study does explore some of the characteristics of stuttering reduction associated with a specific condition of fluency enhancement: choral reading. We believe that more information of this type is necessary to support future large-scale analyses of the commonalities and differences in the fluency induction properties of specific conditions. At present, it is possible to compare the characteristics of fluency enhancement under choral reading with those associated with FAF, given that the present study is virtually identical in design to a recent investigation of FAF conducted by Armson and Stuart (1998). Both studies investigated degree of stuttering reduction both initially and over extended duration of exposure to the condition using an *ABA* time series design. Both studies evaluated individual as well as group responses. Comparisons of the results reveal substantial differences. Specifically, stuttering reduction during choral reading is substantially less variable than during FAF, both across participants and across time. Whereas all participants in the present study exhibited reductions in stuttering of 77.6-99.6% during choral reading, only three participants in the Armson and Stuart study displayed stuttering reductions of greater than 50% during FAF. In addition, stuttering reduction did not deteriorate over extended exposure to choral reading. On the other hand, the degree of stuttering reduction under FAF was shown to deteriorate over time for a majority of participants: Armson and Stuart found that only 3 of 12 participants exhibited stable reduction in stuttering frequency during extended exposure to FAF.

In proposing three categories of fluency enhancement, Armson et al. (1995) grouped both choral reading and FAF under the category of altered speech input. Following Kalinowski et al. (1993), they argued that FAF may be regarded as an electronic analogue of choral speech in that FAF supplies the participant with electronic frequency alterations to his/her own speech signal, while choral reading supplies the participant with speech input from an accompanist. According to this reasoning, both conditions would involve externally-imposed alterations to speech input. The foregoing comparison of fluent speech characteristics suggests, however, that the similarity of FAF and choral reading on the basis of their both involving some type of altered speech input should not be interpreted as indicating that the two conditions share a common process of fluency enhancement. If the underlying process of fluency enhancement were similar, it seems likely that the properties of stuttering reduction as induced by the two conditions would also be similar. Therefore, using the three category notion of fluency enhancement processes proposed by Armson et al., it may be suggested that choral reading should be reclassified as belonging to one of the other two categories of conditions, either internally-imposed speech output alterations or positive speaking-related cognitions. Alternatively, following the

availability of more data describing the fluency induction properties of a variety of conditions, reconsideration of the notion that there are three distinct categories of fluency enhancement may be appropriate. Notably, however, the fact that properties of induced fluency seem to differ substantially across conditions suggests that there may be more than one underlying process.

Clinical relevance. The present study suggests that persons who stutter may be expected to experience near-elimination of stuttering while reading chorally, an effect that should last during extended exposure to this situation. Previous research (e.g., Eisenson & Wells, 1942; Pattie & Knight, 1944) indicated that dramatic reductions occur even during difficult speaking situations, such as speaking before an audience. Therefore, choral reading may be a useful clinical tool for demonstrating the potential for marked improvements in fluency to persons who stutter severely. Furthermore, choral reading in audience situations may be a good strategy for use in the classroom where it may be important to include a child who stutters in an activity that involves public speaking, but where modification to reduce its level of difficulty would make the activity more tolerable to the child.

Implications for Future Research

Information in the present study about extent and stability of stuttering reduction during choral reading is important because it may be used to better understand processes that underlie fluency enhancement. Such data will be most informative when interpreted in combination with data pertaining to the stuttering reduction properties of a wide variety of fluency enhancement conditions. In the past, investigations of fluency enhancement were largely limited to determining the degree of stuttering reduction for a group of participants during a brief sampling of speech. While short term effectiveness is useful information, it is also important to obtain data about numerous other properties of stuttering reduction across a variety of conditions. Recently, investigations of altered auditory feedback have reported some data of this type. In addition to degree of stuttering reduction during extended exposure (e.g., Armson & Stuart, 1998; Ingham et al., 1997) which was previously described, studies have reported findings pertaining to speech naturalness (Ingham et al., 1997; White, Kalinowski, & Armson, 1995) as well as degree of stuttering reduction in difficult speaking situations (Armson, Kalinowski, Foote, Witt, & Stuart, 1997; Zimmerman, Kalinowski, Stuart, & Rastatter; 1997) and across different speaking tasks (Armson & Stuart, 1998; Ingham et al., 1997). More data of this type for a wide variety of fluency enhancement conditions would be useful in understanding how such conditions are similar and how they differ. From such comparisons, postulations about number, and possibly the nature, of underlying processes may be made. Further, full explication of the fluency enhancing attributes of a wide variety of conditions as well as increased understanding of the underlying fluency enhancing processes may lead to refinements in the treatment approaches for stuttering.

Author note

This research was conducted as a master's thesis by the first author under the supervision of the second author. We would like to thank the following people for their help during the conduct of this research and suggestions regarding the thesis manuscript: Walter Green, Elizabeth Kay-Raining Bird, and Melanie Campbell.

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