Effects of a Metronome on the Filled Pauses of Fluent Speakers

Research Note

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Filled pauses (the "ums" and "uhhs" that litter spontaneous speech) seem to be a product of the speaker paying deliberate attention to the normally automatic act of talking. This is the same sort of explanation that has been offered for stuttering. In this paper we explore whether a manipulation that has long been known to decrease stuttering, synchronizing speech to the beats of a metronome, will then also decrease filled pauses. Two experiments indicate that a metronome has a dramatic effect on the production of filled pauses. This effect is not due to any simplification or slowing of the speech and supports the view that a metronome causes speakers to attend more to how they are talking and less to what they are saying. It also lends support to the connection between stutters and filled pauses.

KEY WORDS: filled pause, stuttering, disfluency, automaticity, metronome

Filled pauses are among the most common forms of disfluency in spontaneous speech (Mahl, 1987). These "ums," "ers," "ahhs," and "uhhs" can occur hundreds of times per hour, and it is a rare speaker who can talk for long without at least one intruding in spontaneous speech (Schachter, Christenfeld, Ravina, & Bilous, 1991). Two sorts of explanations have traditionally been advanced for the existence of filled pauses (FPs). One is based on the notion that they reflect the level of anxiety of the speaker, with nervous speakers more likely to litter their speech with filled pauses (Jurich & Poison, 1985). The other suggests that they are a function of the complexity of the speech. When people say more difficult things, they are more likely to say "um" (Rochester, 1973).

Neither the anxiety nor the speech-difficulty explanations, however, is capable of explaining the findings on the determinants of filled pauses. Mahi (1956, 1987) studied the response of a variety of disfluencies to anxiety, largely during psychiatric interviews, and found that whereas most disfluencies increased with anxiety, filled pauses did not. The consistency of this finding led him to exclude filled pauses from his general speech disturbance index. Similarly, Christenfeld and Creager (1996) found that manipulating anxiety without changing the topic of the speech seemed to increase some disfluencies, such as restarts and repetitions, but did not increase filled pauses. In fact, there was a marginally significant trend the other way. Although there are a few studies that suggest a link between anxiety and filled pauses, the majority do not (see Rochester, 1973, for an early review of this work, and Christenfeld & Creager, 1996, for a more recent survey).

The task difficulty work also cannot explain the full range of data, although, as with anxiety, there are some studies consistent with this approach. It is, in fact, possible to subsume the anxiety approach into the task difficulty theory, if one accepts that anxiety interferes with all complicated ongoing behavior, and thus its effect is to make speech more difficult (Mahl, 1967). Siegman and Pope (1966) found more filled pauses when speakers described more ambiguous Thematic Apperception Test cards, which may be a more difficult verbal task. Similarly, Wanner (1990) found that professors use more filled pauses in advanced than in introductory classes.
However, when speech difficulty is manipulated directly, even though word length and the variety of the vocabulary increase, filled pauses do not respond (Christensen & Creager, 1996). Similarly, when the size of the vocabulary is manipulated, the speakers who use more words actually produce fewer filled pauses (Christensen, 1994).

An approach to filled pauses that seems more successful is the notion that they reflect not anxiety or task difficulty, but rather speakers' concern with their speech. That is, when people are monitoring what they say, they may be more likely to say "um." Making speakers attend to their speech output, for example by letting them hear it amplified as they speak and placing a large microphone in front of them, increases the frequency of filled pauses. Similarly, subjects who have had more to drink, and are presumably paying less attention to what they are saying, will say "um" less (Christensen & Creager, 1996).

The self-consciousness explanation for filled pause production is similar to more general theories about the role of monitoring in speech production. Levelt's (1989) model, for example, suggests that people monitor what they are saying at several levels, and that filled pauses are produced when the speaker detects an error, or an impending error, and stops to correct it. This removes the speech production from its normally automatic, unconscious mode, and brings the process into the realm of conscious attention. Ums are a symptom of this process. Postma and Koel (1993) offer a similar account in their covert repair hypothesis. They suggest that people monitor the phonetic plan before it is executed and can repair it before they have made an overt error. This repair, however, can lead to disfluencies such as filled pauses. People may be more accurate at saying what they mean when they control what they say, but they pay a price in certain forms of disfluencies.

The deleterious effects of deliberate attention to well-learned tasks is not unique to speech. Baumemeister (1984), for example, argues that conscious attention to skilled manual performance can disrupt that performance. He shows that asking people to think about what their hands are doing makes them worse at a mental game, as does letting them know that they are being evaluated.

These sorts of explanations are conceptually quite similar to the sorts of explanations that have been offered for some time as accounts of stuttering. Although definitions vary, stutterers are generally considered within-words disfluencies (Conture, 1990) that may involve part or whole word repetitions, elongations, or blocking (Karniol, 1995). They can be produced both by people who stutter (broadly defined as those who produce more than three within-word disfluencies per 100 words) or by people who do not stutter (those with fewer than three per 100 words). Postma and Koel's (1993) covert repair hypothesis includes among the signs that a covert repair is being made both stutterers and filled pauses. Their model is designed to deal with the disfluencies and errors both of people who do not stutter as well as those of people who do. Dealing more specifically with people who do stutter, West (1931) has suggested that trying to produce individual speech movements, rather than "automatic serial responses" may be a cause of stuttering. Mysak (1990, 1986), borrowing from cybernetics for his servo theory of stuttering, has also made similar suggestions, arguing that there is a failure in the feedback system of those who stutter.

Bloodstein (1987) offers a general review of the various forms that these "anticipatory struggle" type of hypotheses have taken.

Karniol (1995) has also suggested that stuttering does not represent a deficit of the motor control of speech, but instead indicates that the speaker is modifying the prior speech plan. She suggests that it is specifically the attempts to reformulate the suprasegmental plan (the rhythm, melody, or stress of the speech) in midstream that produces stuttering in those who are slow with either lexical access or syntax. For example, people who change their minds about what to say may stutter while they try to change the prosodic aspects of the speech so that what they were saying connects to what they now intend to say, while this suggests a more specific cause than simply correcting any sort of error, it is similar in that it argues that stuttering is produced when people interfere with the flow of their speech.

If it is true that stutterers reflect deliberate involvement in the act of speaking, either to correct an error or to reformulate the suprasegmental plan, and also true that filled pauses are increased by this attention, then it ought to be that manipulations that alter the rate of stuttering also alter the frequency of filled pauses. In the present experiment, the effects of a metronome on the spontaneous speech of people who do not stutter are examined. It is well documented that a metronome is effective in reducing stuttering (Kingly, 1939), The amelioration of stuttering does not depend on the noise of the metronome distracting the speaker, since the same noise without the requirement for synchronization does not produce the effect (Beech & Dubb, cited in Beech & Fransella, 1969). Nor does the effect depend on slowing the speech rate, since stuttering is reduced even when the speech rate is not (Hanna & Morris, 1977). The reduction in stuttering also is not simply a function of the metronome blocking auditory feedback, since it also exists for a tactile rather than auditory metronome (Azrin, Jones, & Flyn, 1968).

There are several studies that, following similar reasoning, examined the effect of techniques that are known to alter stuttering on the speech of people who do not stutter. For example, Silverman and Goodban (1972) tested the effects of masking noise on a variety of disfluencies of normal speakers while they read aloud. This has long been known to decrease the rate of stuttering (Shane, 1955) and Silverman and Goodban found that it also significantly reduced the part-word repetitions and revisions of normal speakers. Postma and Koel (1995) also manipulated masking noise and found a decrease in disfluencies and self-repairs. These sorts of studies provide compelling evidence that manipulations can have similar effects on normal speakers and stutterers. Since both of these studies use reading tasks, they did not examine filled pauses, which do not occur often during reading, but are remarkably common during spontaneous speech.

The effect of a metronome on the speech of people who do not stutter has also been examined by Stager and Ludlow (1993). However, they were concerned not with rates of
disfluencies but with the precise timing of aerodynamic variables in metronome-paced speech. Their study analyzed the reading of simple sentences, so filled pauses and other disfluencies of spontaneous speech did not have the opportunity to occur.

Although it is not completely clear why the metronome is effective in reducing stuttering (Wingate, 1976), it is possible to reconcile the effect with the general monitoring explanations for stuttering. The metronome could change the way people control their speech and the kinds of monitoring they can do while producing this sort of synchronized output. By focusing attention on how they are talking, people may have less time to monitor what they are saying. The metronome might thus make them less likely to interfere with the ongoing speech. If the proposed accounts for filled pauses is correct, then a metronome should reduce the frequency with which they are produced. If, on the other hand, filled pauses do not reflect this sort of interference with the normally automatic aspects of speech, then a metronome should not reduce them. It could even be the case, if filled pauses do not reflect interference with ongoing speech but instead the difficulty of the speech, that the extra mental effort of synchronizing speech to the beats of a metronome could actually lead to a greater number of filled pauses being produced.

Postma and Kotr’s (1992) procedure required subjects to repeat a series of sentences they had memorized. In addition, half of the sentences were tongue-twisters, and they were repeated under varying degrees of time pressure. These factors are likely to lead to fairly high overall rates of errors and disfluencies such as omissions, substitutions, and repetitions. It may not be possible to examine these errors in the present study, because short, simpler speeches are generated. However, it should be possible to examine, in addition to the filled pauses that are so common in spontaneous speech, various measures of the complexity of the speech produced in the metronome conditions. This allows some investigation into whether the metronome effect is due to changes in the way the speech is produced or changes in what words or utterances are produced. For example, subjects could compensate for the greater difficulty of the metronome conditions by producing much simpler speech. It was the purpose of the present experiment to examine whether a metronome reduces filled pauses in the speech of people who do not stutter, just as a metronome has been shown to reduce the stutters of people who do stutter.

STUDY 1

Method

Subjects

Thirty undergraduate subjects participated in the experiment as part of a course requirement. Fourteen of the subjects were male and 16 female. They ranged in age from 18 to 21, with a median age of 19. All subjects spoke English as their primary language and none reported any history of speech or language disorders. None indicated having had any prior experience synchronizing speech to a metronome.

Apparatus

A small electronic metronome that emitted a clearly audible beep was used. This was set to three different rates, 150 beats per minute, 180 beats per minute, and 210 beats per minute. These three rates were chosen because it was thought that they would produce a speech rate in roughly the normal range. Given that spontaneous speech has 125-180 words per minute without a metronome (Yeni-Komshian, 1993), if subjects produced one word for each beat, then the rate of 150 should lead to a normal rate. On the other hand, if speakers produced one syllable per beat, then the higher metronome rates should lead to a normal speech rate.

The subjects’ speeches were recorded on a small portable tape recorder placed in front of the subject. Transcripts were made of each speech from these recordings.

Procedure

Subjects were asked to describe classes that they were currently taking. They were told that they could pick any class they wanted and, for about a minute, say anything that occurred to them about that class. Each subject described four classes, once without the metronome and once with the metronome set at each of the three rates. The order in which they did these four tasks was counterbalanced. There was no effect of order on any dependent variable, and all analyses are collapsed across this factor.

Before their first class description with the metronome, the subjects were given instructions about the metronome. They were told, “For this next description, I want you to try to synchronize your speech in some way with the beating of this metronome. It’ll beep while you talk, and you can do the words in a way that you find comfortable.” The subject described the speech. For later descriptions with the metronome, the subject was told the task would be the same as before, except that the metronome would be set at a different rate. Again, the device was started, and the subject told to begin whenever ready.

While the subjects spoke, the experimenter unobtrusively counted their filled pauses. Filled pauses were defined as the sounds “uh,” “um,” “er,” and “ah.” If several of these were produced in succession, each one was counted in the total. Such utterances as “I mean” or “you know” were not included. There are numerous different schemes for categorizing errors and disfluencies. LaSalle and Couture (1995), for example, called “I mean” and “you know” editing terms,
and put them in the general category of covert repairs with filled pauses. However, the categories of Rochester (1973) are used here and only such semantically meaningless sounds as "um," "er," "uh," and "ah" are counted as filled pauses (Rochester, 1973).

The speech complexity measures were coded from the transcripts of the speeches. Each of these measures was calculated by two independent raters to allow an assessment of reliability.

**Analyses**

The main dependent variable, filled pauses per minute, was analyzed with a one-way repeated measures ANOVA, using metronome condition as the independent variable (none, 150, 180, or 210 beats per minute). The speaking rate (syllables per minute) and filled pauses per syllable were analyzed in the same way. When the ANOVA was significant, pairwise comparisons were assessed using the Scheffe test to control the overall Type I error rate. For all such tests, the alpha level was set at .05. The speech complexity measures (syllables per word, and type/token ratio) were analyzed with paired t-tests, comparing the no-metronome condition to the average of the three metronome conditions. Reliability of each dependent variable was assessed by computing the intraclass correlation coefficient for the pair of raters (see Fleiss, 1986, for more details on this procedure).

To assess the reliability of the FP counts, a second judge coded the tapes for the number of FPs uttered and the duration of the speech samples. The computed reliability of the FP/Min dependent variable was \( R = .99 \). Counting filled pauses is about as simple as producing them.

**Results**

**Effects on Filled Pauses**

The average length of the class descriptions was 48.8 words and they ranged from 15 words to 316 (SD = 98.7). For most of these, these are brief and simple speeches, but more than enough to generate an abundance of filled pauses in the condition without the metronome. These descriptions had, on average, about nine filled pauses per minute. The data, shown in Table 1, also demonstrate a dramatic metronome effect, \( F(3, 87) = 33.35, p < .0001 \). When the subjects were speaking without the metronome, their filled pause rate was almost four times as high as when they were speaking to the metronome. The frequency of filled pauses was significantly higher in the condition without the metronome than in each of the three conditions with the metronome and these three did not differ from each other, as assessed by the Scheffe HSD.

**Effects on Speech Complexity**

To see if the subjects compensated for the added difficulty of synchronizing their speech to the metronome by producing simpler speech, we examined the length of the words they used, the diversity of their vocabulary, and their speech rate in the various conditions. To examine word length, the average number of syllables per word was calculated from transcripts of all of the class descriptions. Due to equipment malfunctions, the descriptions of 2 subjects could not be transcribed. For those 2 subjects, the speech complexity measures are based on the remaining two class descriptions. Excluding them from the data does not change any result. The interrater reliability for the syllables per word measure was \( R = .95 \). There is no significant difference in average word length between the three metronome conditions and the normal speech, \( t(29) = .54, \text{ ns} \).

There are also no differences in the size of the vocabulary used. The type/token analysis is a measure of how many different words (types) a speaker uses out of a standard number uttered (tokens). Because the ratio depends on the length of the speech analyzed, for each subject the four descriptions were trimmed to the length of the shortest one. On average, this produced a speech sample of 32 words. The reliability of this measure was \( R = .89 \). The type/token ratio is no lower for the metronome conditions than for the non-metronome speech, \( t(29) = 1.06, \text{ ns} \).

The speech rate issue is slightly more complex. The speech rate was calculated as the number of syllables uttered from the time the subject starts speaking to the time he or she stops. Periods of silence were not subtracted, so the rate may be slightly slower than speech rates that assess only the rate of articulation. Silent pauses were not subtracted from our measure because speakers could well be using these periods to plan the next part of the utterance. That is, the metronome might have its effect because it causes people to substitute silent pauses for filled pauses when they need extra time to plan what they will say.

The intraclass reliability coefficient for speech rate was \( R = .96 \). The speech rates for the four conditions are shown in Table 2. Clearly, there are differences in the speaking rate, and these are significant, \( F(3, 81) = 38.70, p < .0001 \).

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<tr>
<th>TABLE 1. Ums per minute (and standard deviations) for class descriptions with three speeds of metronome and no metronome (( n = 30 )).</th>
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<td><strong>Metronome speed</strong></td>
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Note: Values with a different superscript differ significantly at \( p < .05 \) (Scheffe).

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<th>TABLE 2. Syllables per minute (and standard deviations) used in class descriptions with three speeds of metronome and no metronome.</th>
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Note: Values with a different superscript differ significantly at \( p < .05 \) (Scheffe).
speed of the metronome had an effect on the speech rate of the subjects, and all three metronome speeds produced slower speech than the no-metronome condition. (Because there was no hint of difference between conditions in word length, the findings are identical if they are computed with words per minute rather than syllables per minute.) Speakers, for the most part, synchronized syllables rather than words to the beeps of the metronome. However, the speakers did not produce a syllable for every beep. With the metronome set at 180, for example, they produced 152 syllables per minute, indicating that they produced a syllable for 84% of the metronome beeps. When they drifted out of sync with the metronome, they often paused for a few beats to pick up the rhythm again, and this resulted in a slower speech rate.

Since it must be easier to make 172 syllable-choice decisions per minute (the average of the metronome conditions) than to make 214 such decisions (the rate without a metronome), the slowing explanation seems, at first blush, satisfactory. However, there are several reasons to think that the reduction in filled pauses is not due to the change in speech rate. For example, the effect of a metronome on stuttering does not depend on its slowing the speech (Hanna & Morris, 1977). Furthermore, if the ums reflect the number of decisions that the speaker must make per minute, then one would expect the different metronome rates to produce different filled pause rates. Although there are large differences in the speech rates of the three metronome conditions, there are no differences in filled pause rates. Furthermore, when the FPs per syllable produced, rather than per minute of talking, are compared, the metronome speech is still dramatically lower than the normal speech, F(3, 81) = 14.08, p < .0001.

The most compelling evidence against the slowing explanation, however, comes from a small follow-up study in which subjects are given a few minutes to practice synchronizing their speech with the metronome. This practice should help them avoid getting out of sync and having to stop to get the rhythm back and also should allow them to get over any anxiety they might feel about appearing silly. For these reasons, they should be able to increase their speech rate in the metronome conditions. The second experiment, then, explores whether the effect of the metronome persists even when subjects are allowed some time to get used to speaking with the metronome.

STUDY TWO

Method

Subjects

Eight subjects who had not participated in the first experiment were recruited. As in the first experiment, they participated in exchange for course credit. Again, for all subjects English was the primary language, and none reported any history of speech or language disorders. There were 4 females and 4 males with ages ranging from 17 to 22 (median = 18).

Procedure

Subjects practiced metronome speech until they were fairly comfortable with it. This generally took just a few minutes. To make the subjects even more comfortable with the procedure, the experimenter did a more extensive demonstration of metronome-synchronized speech, both with one syllable occurring per beat and with one word occurring per beat. When the subjects appeared comfortable with the procedure, they described one class with the metronome beeping 210 times per minute and one with the metronome set for 230 beats per minute. This faster rate was chosen to help ensure that the metronome speech would be at least as fast as the no-metronome speech. They also produced one description without the metronome. In all other respects, this experiment was carried out in the same manner as the previous one. The order of the three speeches was randomized and again there was no effect of order on any dependent variable.

Results

The data shown in Table 3 indicate that the subjects were able to attain, and even exceed, their normal speech rate while talking to a metronome. The differences among the speech rates in the three conditions are not significant, F(2, 14) = 1.24, ns, but the metronome speech is certainly no slower than the normal speech. These speakers spoke unusually slowly in the condition without a metronome. However, the rate that they generated with the metronome is essentially as fast as the rate of the previous experiment's subjects in the no-metronome condition. If the metronome's effect depends on its slowing the speech, then there should be no effect in this experiment, and the metronome conditions should produce as many filled pauses as the non-metronome condition of the first experiment. The data, however, remarkably similar to those from the previous study, show a dramatic and significant decrease in ums in the metronome conditions, F(2, 14) = 9.06, p < .005. Again, there is no difference in the frequency of filled pauses between the two metronome speeds. These data cast doubt on any argument about the metronome's effects being due to slowed speech. The average speech in this experiment was 40.8 words long (SD = 20.8).

The notion that self-consciousness about speaking, or increased monitoring of the speech plan, produces disfu-

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<th>TABLE 3. Speech and um rates (and standard deviations) for subjects who were allowed to practice with the metronome.</th>
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Note: Values with a different superscript differ significantly at p < .05 (Schefl).
encies makes a further prediction that can be tested with our existing data. If deliberate involvement with speech is the part that leads to filled pauses, then people should be especially likely to begin an utterance with an "um." Even if people can talk without much thought, they still have to decide consciously to start talking. The subjects were told to begin talking whenever they were ready, and they knew there was no possibility of interruption. Yet many of them sat in silence until they had decided what to say, and then said "um." When subjects describe a class without the metronome, they produce, on average, one filled pause for every 20 words uttered. If these were distributed randomly throughout the speech, then 5% of the speeches should begin with a filled pause. However, 33% of the speakers began with a filled pause.

General Discussion

It is quite clear that a metronome has a dramatic effect on the production of filled pauses. Furthermore, this effect cannot easily be attributed to changes in the complexity of the speech produced. The words are no shorter, the vocabulary no less varied, and the speech rate no slower, yet the filled pauses are diminished.

The finding has two implications. First, the reduction in filled pauses when people are forced to attend to the rhythm rather than the content of their speech, supports the deautomatization explanations for filled pauses (Christenfeld & Creager, 1996; Postma & Koik, 1993). That is, the metronome may prevent speakers from monitoring or stopping to correct their speech and so it will be produced with fewer filled pauses. If there are fewer covert repairs, there should be fewer "ums." This notion is also supported by the finding that filled pauses are especially likely at the start of an utterance. At these points, the speech system is unlikely to be running automatically. Even though people may know what they want to say, the decision must be made to start talking, and this transition seems to be an especially likely spot for a filled pause.

The second implication concerns the relationship between filled pauses and stutters. The fact that a metronome has a very similar effect on filled pauses as the one previously documented for stutters provides more evidence that the two sorts of disfluencies do not represent distinct categories. A number of people have argued that stuttering shares characteristics with "normal" speech disfluencies, and thus disfluent speech falls on a continuum (Bloodstein, 1987; Brutten & Shoemaker, 1967; Korni1, 1995).

The overlap between filled pauses and stutters is supported by three sorts of evidence. The strongest evidence includes findings that manipulations that alter one also alter the other, as shown here. The second sort is, as discussed earlier, the similarity of the theoretical explanations that have been offered for their occurrence. Both are thought to result from an increase in the attention paid to the ongoing speech. The third sort is that they tend to fall in the same places in the speech stream. LaSalle and Conture (1995) have shown that covert repairs, such as filled pauses, are especially likely to cluster with stutters in the spontaneous speech of children who stutter. The filled pauses of people who do not stutter also tend to fall in the same places as the stutters of people who do stutter. Filled pauses almost never fall within words and there is evidence that stutters tend to occur mostly on the first syllable rather than in the middle of a word (Beech & Fransella, 1968). Stutters tend to occur at the start of longer, and less common, words (Brown, 1945), as do filled pauses (Goldman-Eisler, 1968). Furthermore, stutters fall more often than expected by chance at clause boundaries (Quarriington, Conway, & Siegal, 1962), the same tendency that has been documented for pauses (Henderson, Goldman-Eisler, & Skarbeck, 1968). Finally, stutters are most common at the start of a sentence (Koopmans, Silis, & Rietveld, 1991), as are filled pauses (Boomer, 1985).

There are, of course, important differences between stutters and filled pauses. For example, stuttering is relatively uncommon and it is quite noticeable. On the other hand, essentially everyone uses filled pauses, but they are rarely noticed by the audience. People who were attending to the content of the speech did not notice the difference between nine filled pauses per minute and zero (Christenfeld, 1995). It is at least conceivable, therefore, that people who stutter might be able to improve their apparent fluency by saying "um" during repairs rather than stuttering. That is, without changing the rate of covert repairs, or the activation rate of phonemes that might lead to the need for such repairs, people replacing stutters with filled pauses might make the resulting speech appear more fluent. Gottwald and Starkweather (1985) have similarly suggested that clinicians might model word and phrase repetitions to demonstrate an alternate technique for gaining time to plan the next part of the utterance. Replacing stutters with less noticeable "ums" is clearly quite speculative and more work is needed on both the causes and consequences of disfluencies, but the similarity of the two forms studied here could have some clinical significance.

References


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