# VOCAL AND SUBVOCAL SPEECH IN STUTTERERS AND NON-STUTTERERS

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## ABSTRACT

The methodology of subvocal speech was used to assess whether stuttering already exists at the pre-motor stage of the speech production process. In realizing CVCV sequences non-stutterers (NST) were faster than stutterers (ST), both in vocal and subvocal speech. Also, ST produced vocal speech just as fast as subvocal speech, what leads us to conclude that in subvocal speech of ST different factors play a role than in subvocal speech of NST.

## INTRODUCTION

The deviant speech of ST has been approached from many points of view. Differences with speech of NST have been searched for in linguistic planning [1], in the articulatory planning and in articulatory execution of speech. Especially in the last two approaches the concept of *articulation difficulty* plays an important role. Specific segments, like initial /g,d,l,p/, are assumed to be more difficult for ST than others, like /w,s,f,h/ [2]. Another factor appears to be the similarity of consonants on identical syllable positions [2]; it was found that consonants which differ by only one Distictive Feature (DF) enhance stuttering, compared to more dissimilar consonants. It is still not clear, however, whether articulatory problems should be located only at the execution level of speech, or also in the planning stage. There is evidence, yet, that articulatory obstacles are to be found in the planning stage as well. [3] for instance, showed for normal speakers a qualitative similarity between 'slips of the tongue' in overt and covert speech, whereas [4] reported that subjects need more time to silently read sentences with tongue twisters than matched sentences without this kind of obstacles. These findings suggest that articulatory problems also show up at the planning stage of speech. The methodology used in the research reported above is that of *silent reading*, which is equivalent to *subvocal* or *covert* speech. It offers the opportunity to tap the speech production process at the pre-execution stage, where movements of the speech organs are not yet initiated, and do not provide feedback in order to signal whether targets are reached or not. This is a particularly favourable situation to assess whether differences between the speech of ST and NST mainly exist at the execution stage, or already at the pre-motor stage.

This contribution focusses on the differences between vocal and subvocal speech of ST and NST. We did not investigate stuttered speech, but restricted ourselves to *perceptually fluent speech*, i.e. speech which is fluent in the overt condition (OC). Matched speech samples in the covert condition (CC) are considered to be fluent too. It is well-known, however, that perceptually fluent speech of ST is often slower than that of NST. Thus the deviance of planning and/or execution in ST' speech can manifest itself in the rate of speech.

Our hypothesis is that stuttering, or its manifestation in fluent speech: lower speech rate, is not (only) located in the articulatory/motoric execution stage. This hypothesis implies the following predictions when comparing vocal and subvocal speech of ST and NST:

1) ST need more time for the realization of speech in both the CC and OC than NST;
2) ST and NST need more time in the OC than in the CC, as the former is an additional, time-consuming part in the process of speech production;
3) The difference in speech durations between ST and NST is less for *simple* sequences than for *difficult* ones.

## METHOD

### Speech materials

It was decided to use CVCV nonsense words for the sequences to be realized both in OC and CC. There were three reasons why this type of words was used: a) nonsense words leave more freedom for phonetic composition, b) an emotional load for stutterers is avoided, and c) less stuttering is observed on nonsense than on normal words [2]. The words were varied along a number of dimensions, which are assumed to be related to rate of speech or the facilitation of stuttering. [5] found that a relatively large dissimilarity between consonants on corresponding syllable positions increases the rate of speech, while Soderberg [2] observed a high frequency of stuttering on words in which the corresponding consonants differ by only one DF. Thus we created a dichotomy of words which are or are not assumed to stimulate stuttering or reduce speech rate. The dimensions are:

1) The number of DF's in which consonants with corresponding syllable positions differ (0 - 6 DF's). For instance the consonants of the word *piepe* do not differ in their segmental make-up, whereas the word *siene* has consonants that differ in 5 DF's.
2) Initial consonants which are known to facilitate stuttering, like /g,d,l,p/ and consonants which do not facilitate stuttering: /w,s,f,h/.

By combining these two dimensions we eventually tested two types of sequences: *difficult* sequences that maximally enhance stuttering and *simple* sequences that do not facilitate stuttering.

### Subjects

Both groups contained 12 subjects matched for sex and age. Both ST and NST were classified according to quantitative stuttering severity by means of the *Stuttering Severity Instrument* [6]. The ST showed *very mild* (N=3), *mild* (N=4), *moderate* (N=4) and *severe* (N=1) stuttering behaviour. The speech of NST was classified as *very mild*, even though most of them showed no dysfluencies at all. A model for a differential diagnosis and treatment of stuttering [7] was used to determine the qualitative stuttering behaviour: in all ST a motor dysfunction was dominant, characterised by lengthening, blocks and non-verbal struggle behaviour.

### Procedure

The condition for realizing a sequence was displayed on a computer screen, being either *aloud* (OC) or *quietly* (CC). The subjects was told that *quietly* was the equivalent of repeating a telephone number or a list of shoppings in their mind. During this display the subjects would prepare themselves to overtly or covertly producing the sequence by either opening the lips a little so that they could start articulating the sequence as soon as it appeared on the screen (OC) or by clamping the tongue between the teeth and keeping the lips apart (CC) to prevent the articulators from making the same articulatory gestures as in OC. When the sequence appeared on the screen the subjects had to start repeating it in the proper condition as fast as possible, meanwhile maintaining a precise articulation. With every repetition (both in OC and CC) they simultaneously had to press a key which was connected to a computer that calculated the average realisation duration of every sequence. This way, in OC, the speech production process at the execution stage was tapped. The durations tapped in the CC represented the execution duration in the pre-execution stage only. In order not to include possible speeding up at the beginning of repeating a sequence and/or slowing down at the end, only the five intervals in the middle were used for computing the average duration of every sequence.

## RESULTS AND CONCLUSIONS

The mean realization durations of NST ranged from 217 ms to 554 ms in OC and from 178 ms to 435 ms in CC. For ST the mean durations ranged from 191 ms to 655 ms in OC and from 230 ms to 818 ms in CC. Analysis of variance showed a significant effect for Group (df=1, $F(1,22)=4.85$, $p=.04$) and for Difficult versus Simple sequences (df=1, $F(1,22)=7.79$, $p=.01$). The interaction between Group, Condition and Difficult versus Simple sequences (df=1, $F(1,22)=6,43$, $p=.02$) is depicted in figures 1 and 2.

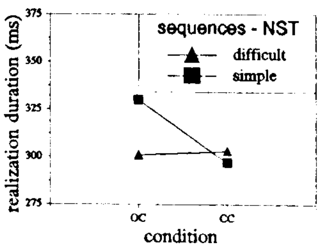


*Figure 1. Interaction for NST between Condition and Difficult versus Simple sequences.*

Looking at the first prediction made in the introduction, it appears that NST realize all difficult and simple sequences in both conditions faster than ST, the mean difference in CC (69.1 ms)

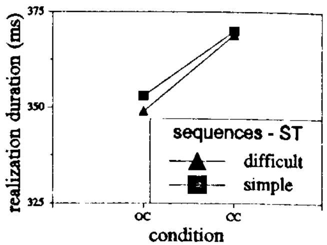


*Figure 2. Interaction for ST between Condition and Difficult versus Simple sequences.*

being considerably larger than in OC (35.5 ms). That ST would perform the task at a lower rate than NST in OC was to be expected. It was observed in earlier experiments that, in addition to a more general motor slowness [8], ST have an articulatory slowness as a result of increased muscle tension. Even in perceptually fluent speech they significantly differ from NST with respect to speaking rate [9] [10] or physiological characteristics like subvocal pressure [11]. The finding that ST were also slower in CC confirms our first hypothesis that the delay in speech of ST can be reduced to the pre-execution stage. However, we have to be careful with this conclusion as will be seen when discussing the second prediction.

Looking at the overt - covert dichotomy, it appears that NST are slower in OC than in CC, the mean difference being 15.3 ms. As opposed to NST, ST produce the sequences faster in OC than in CC, the difference being 18.3 ms. Although the execution stage is eliminated in CC, ST need more time in CC than in OC. Probably additional factors play a role here, like auditory or proprioceptive feedback or behavioral factors, that could have caused time delay in stead of gain. ST could have



been more aware of their speech than NST. In performing the, very unusual, CC task they might have felt insecure about their performance. In trying to perform as good as possible, ST may have adjusted to the task by taking more time to be able to 'control' their responses, especially when both auditory and proprioceptive feedback were not available as monitoring mechanisms. The influence of sensory feedback is considered to be unequal for the speech of ST and NST, but disordered sensory feedback as an explanation for stuttering is still under debate [12].

The simple versus difficult dichotomy does not seem to influence the realization rate of ST, independent of condition. For NST the same holds for CC, but in OC something strange happens: NST need more time for the sequences that were considered *simple* than for the sequences that were considered *difficult*.

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