

INFLUENCE OF PUBLIC SPEAKING ON THE CONTROL OF VOWEL DURATION IN STUTTERING AND NONSTUTTERING ADULTS - PRELIMINARY RESULTS

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INTRODUCTION

In a series of experiments a mechanism for the control of vowel duration was detected, named ‘audiophonatory coupling’ (Kalveram & Jäncke, 1989; Jäncke, 1991; Natke, 1999). In the respective experiments, subjects had to utter a test word repeatedly while their auditory feedback was electronically either delayed or advanced in time during single trials. Under delayed auditory feedback with delay intervals below 50 msec, vowel duration of long stressed syllables was prolonged up to 80 % of the delay interval. Vowel related advanced auditory feedback was realized by playing back a vowel stored in a computer, which was triggered by a leading consonant (Kalveram, 1984). This led to an advanced feedback of the vowel about 30 msec (corresponding to the voice onset time) ahead of the actual onset of the vowel. In contrast to delayed auditory feedback, advanced auditory feedback caused a shortening of the vowel duration of long stressed syllables. In both, delayed and advanced auditory feedback, the unstressed syllable remained almost unaffected. Additionally, in short stressed syllables the delay did not lead to a prolongation neither. Results indicate that audiophonatory coupling, at least approximately, takes care of the realization of the planned vowel duration. Even if vowel onsets vary due to the complex neuro-physical processes involved in phonation, vowel offset is timed appropriately. This coupling and therefore control of vowel durations obviously depend on duration of syllables and therefore on linguistic stress.

In two experiments a stronger effect was observed in subjects who stutter (Kalveram & Jäncke, 1989; Jäncke, 1991). The vowel duration of long stressed syllables was prolonged more strongly and a prolongation of unstressed syllables was observed, too. Furthermore severely disfluent adults showed a stronger effect than subjects stuttering moderately. The data were interpreted as being an indication of a stronger and possibly dysfunctional use of the auditory feedback channel for speech control by people who stutter. However, group differences in audiophonatory coupling could not be replicated in two recent experiments (Natke, 1999).

All experiments regarding the audiophonatory coupling were conducted in a sound-attenuated room with no other person attending the experiment. However, it is well known that people who stutter tend to show more disfluencies with increasing audience size, while the disfluencies are usually reduced drastically being alone (Bloodstein, 1995). But audience as a factor concerning fluency was not taken into account in most of the experiments regarding sensorimotor control of speech production. If therefore, public speaking is included into the experimental design, differences in fluency between stuttering and nonstuttering people should be more pronounced.

The purpose of this pilot study is to reveal (1) whether a public speaking surrounding influences control of vowel duration and (2) whether stuttering and nonstuttering people differ with respect to this aspect. Thereby, control of vowel duration is measured by the degree of audiophonatory coupling, which is defined as the vowel prolongation in long stressed syllables due to delayed auditory feedback with a delay interval of 40 msec.

METHOD

Subjects

Eight nonstuttering and eight stuttering subjects with German as their mother tongue participated in this study (people who do not stutter: $M=22.5$ years, $SD=2.3$; people who stutter: $M=28.8$ years, $SD=8.6$). All subjects who stutter took part in stuttering therapies, but not in the two years before participating in this experiment. The degree of stuttering severity was determined with Riley's

Stuttering Severity Instrument (SSI; Riley, 1972). Stuttering subjects' mean SSI score was 19.6 (SD=4.1; 2 rated as "very mild", 3 as "mild", and 3 as "moderate"). No subject had a hearing deficit of more than 20 dB (audiometric test: Hortmann DA 323, Neckartenzlingen, Germany).

Apparatus

A headset with closed ear pads (Blackhawk DSP 5DX, Flightcom, Portland, USA) was used to present the target tones (see procedure), to record the subject's voice, and to feed it back after it had been delayed digitally. Delay of auditive feedback was realized with a commercial device (DFS 404, Casa Futura Technologies, Boulder, USA) which operates at a sampling rate of 32 kHz and sampling depth of 14 bit. This delay unit had been modified with a relay to allow remote switching between simultaneous (SAF) and delayed auditory feedback (DAF). Feedback volume was kept constant for all subjects and was perceived as being similar to natural voice volume. Low pass filtered noise (880 Hz, -24 dB/Oct at 70 dB(A)) was presented binaurally to mask bone conduction. Vibration of vocal folds was measured with an electroglottograph (EGG; Laryngograph, Kay Electronics, Pine Brook, USA). An IBM compatible PC equipped with a sound card was used to present the target tones, switching the delay unit between SAF and DAF, and recording the EGG signal at a sampling rate of 11025 Hz, sampling depth of 16 bit.

Procedure

Testing consisted of four phases: After an initial rest phase (15 min), the degree of audiophonatory coupling was measured under the non public (or public) speaking conditions (approx. 5 min). This test phase was followed by a second rest phase (15 min), after which the degree of audiophonatory coupling was measured under the public (or non public) speaking condition. The public speaking condition was realized with a video camera recording the subject and two experimenters sitting 2 m in front of the subject. Under the non public condition, subjects were left alone and the video camera pointed to the side with a lens hood being attached. The sequence of non public and public

speaking was randomized and balanced. The overall duration of testing was 45 min, including automated instructions. In a prior experiment with nonstuttering adults this design has proven successful in creating stress measured in an increase of the heart rate (unpublished data).

Procedure for measuring degree of audiophonatory coupling was as follows. Subjects had to utter the test word [ˈta:tatas] at a speed and with an intonation based on a rhythmical target tone sequence. This sequence consisted of three 440 Hz sinusoidal tones, each separated by 40 msec. The first (“long stressed”) tone had a duration of 400 msec, whereas the following two (“unstressed”) tones each had a duration of 200 msec. Each condition consisted of thirty trials, in which the tone sequence was presented twice, followed by a click noise indicating that subjects should utter the word. The next trial began 3.5 sec after the click noise. Auditory feedback was delayed by 40 msec in 20 % of trials, resulting in 6 DAF trials for each of the two conditions. DAF trials were randomized with the restriction that two SAF trials had to precede one DAF trial. The intermittent and unpredictable occurrence of the delay prevents that adaptation or correction mechanisms are activated before the utterance starts. Subjects were asked to speak clearly and with normal volume.

Data Analysis

Data were analyzed using MATLAB (The MathWorks Inc., Natick, USA). The speech signal was used to control whether the test words had been spoken correctly and, in the case of subjects who stutter, also perceptual fluently. In order to determine vowel duration, the EGG-signal was digitally high-pass filtered (Butterworth type) with a cut of frequency of 50 Hz which eliminates the baseline variations, and then rectified and smoothed per moving average. 1/10 of the maximum value of this signal was taken as the threshold for phonation. Vowel duration was defined as the time, the actual signal exceeds this threshold. In order to avoid that the observations were based on processes of preceding speech segments, only the first long stressed syllable of the test word was analyzed. For data analysis, vowel duration within each subject and each condition was averaged over the 6

DAF trials and over the 6 SAF trials, immediately preceding the delayed ones. There was no missing data.

For comparisons between delayed and simultaneous auditory feedback within the groups, two sided t-tests for dependent samples were calculated. Differences between the groups regarding the prolongation effect were tested with two sided t-tests for independent samples. Two sided p-values without adjustment were reported.

RESULTS

Vowel durations of the first long stressed syllable of the test word under SAF and DAF are shown in Figure 1. Vowel duration increased significantly under DAF compared to SAF in public as well as in non public conditions for both groups. P-values of the two sided t-tests ranged from 0.00255 to 0.00016.

((Figure 1))

Figure 2 shows the vowel prolongation, meaning the difference between the mean vowel duration under SAF and DAF. P-values indicate that the public speaking condition causes a difference in the prolongation effect between stuttering and nonstuttering people. People who do not stutter showed a stronger prolongation effect in the public speaking condition ($M=0.0334$, $SD=0.0129$) than people who stutter ($M=0.0189$ sec, $SD=0.0116$).

((Figure 2))

DISCUSSION

The results concerning the prolongation effects in long stressed syllables were replicated under all conditions. Mean prolongation magnitude was 25.3 msec, which amounts to 63.3 % of the delay interval. Due to the limited number of participants interpretation of results regarding the effects of a public surrounding is difficult. However, results indicate that a public speaking condition influences somehow control of vowel duration. Public speaking conditions seem to lead to a stronger

prolongation effect in nonstuttering people compared to stuttering people. This leads to interesting interpretations concerning motor control of speech, which have to be further investigated with a greater number of subjects. If our preliminary results are supported, a stronger audiophonatory coupling should be the normal mechanism of the speech motor control system to compensate for social stress situations under public speaking conditions. In people who stutter, this mechanism could be missing or even operate the opposite way. Interestingly, results regarding public speaking might contradict former findings concerning audiophonatory coupling in people who stutter. This study yields a first indication of the importance to consider possible effects of public speaking on speech motor control in stuttering and nonstuttering people.

ACKNOWLEDGMENTS

This research was supported by the Deutsche Forschungsgemeinschaft (DFG), grant no. Ka 417/13-3.

ABSTRACT

Most stuttering adults are less disfluent when they are speaking alone, but most laboratory based research concerning speech motor control is confined to situations without any audience, thus eliminating one of the most prominent factors leading to disfluent speech. In an experiment 8 stuttering and 8 nonstuttering subjects had to utter the test word ['ta:tatas] under delayed and simultaneous auditory feedback (delay interval: 40 msec) in public and non public surroundings. In all conditions a prolongation effect was found, replicating former studies. Furthermore, public speaking conditions seem to lead to a stronger prolongation effect in nonstuttering people compared to stuttering people. This study yields a first indication of the importance of public speaking surroundings in stuttering research.

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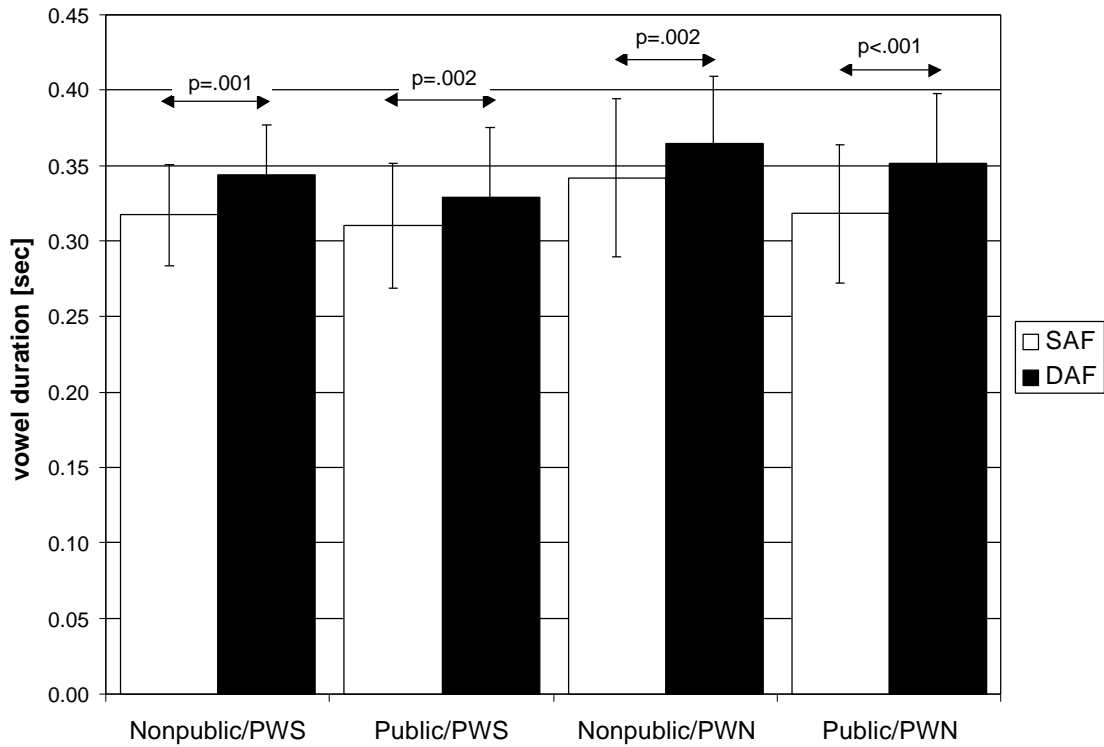


Figure 1: Means and standard deviations for the vowel duration under simultaneous auditory feed-back (SAF) and delayed auditory feedback (DAF; delay interval 40 msec) under public and non public condition for stuttering (PWS) and nonstuttering subjects (PWN). P-values are based on two sided t-tests.

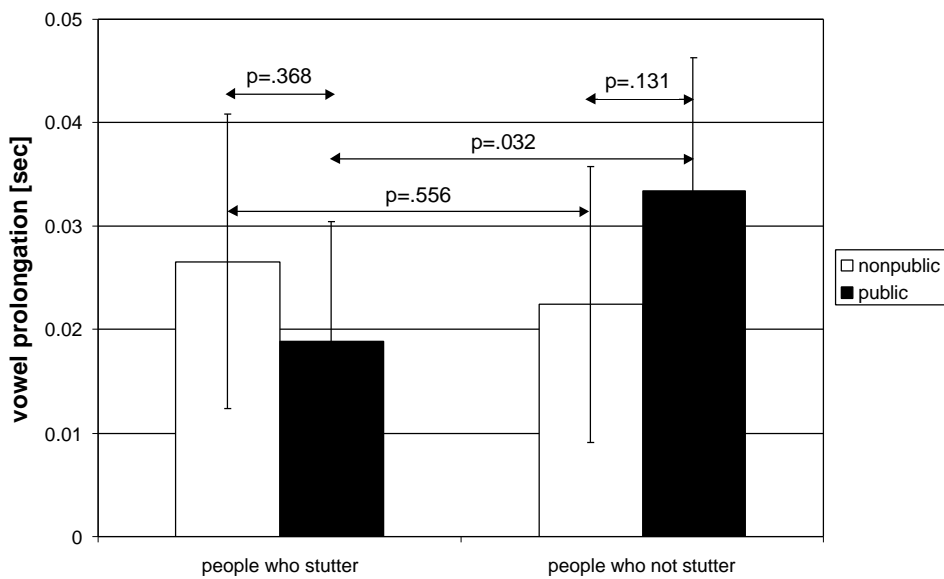


Figure 2: Means and standard deviations for the vowel prolongation under public and non public condition for stuttering and nonstuttering subjects. P-values are based on two sided t-tests.