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EFFECTS OF CONCURRENT MENTAL CALCULATION ON STUTTERING, INHALATION AND SPEECH TIMING

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A dual-task experiment was performed in order to test the assumption that speech disfluencies can result from interference between overt speech movements and concurrently performed cognitive processes. In a word-repetition task, sequences of three unrelated three-syllable nouns had to be repeated continuously. Under dual-task conditions, a mental addition task had to be performed concurrently. Ten adults who do not stutter and nine who do stutter performed the two tasks both separately and concurrently. The two groups were matched for single-task mental calculation performance. Dependent variables were the stuttering and inhalation rates and word duration. It was demonstrated that the expectation of an impending secondary mental calculation task temporarily reduced the stuttering rate but that when the mental calculations were actually performed, the stuttering rate increased beyond the base level for single-task speaking. This result suggests that dual-task conditions temporarily mobilize extra resources for fluent speaking. But as soon as the mental calculation has to be actually performed cognitive processes interfered with fluent speaking, and the stuttering rate was found to increase beyond single-task level. The mental calculation task did not show significantly different effects on the stuttering rates of the two groups, rather, evidence was obtained that for a subgroup of persons who stutter the secondary task interfered with fluent speaking to an extent that was not comparable to that of any person who does not stutter. The results of the present experiment suggest that the occurrence of stuttering events simultaneously depends on the amount of processing capacity required for speech planning, and on the amount of interference between higher-level processes and the fluent execution of speech movements, and that a subgroup of persons who stutter is particularly sensitive to this kind of interference.

Key Words: Stuttering, Dual-task; Mental load; Speech rate

INTRODUCTION

The aim of the present investigation was to test the assumption that concurrent cognitive processes interfere with the fluent execution of speech movements. During speech production, information related to subsequent speech is re-

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trieved from short-term memory and translated into a phonetic code while previously planned portions of speech are being produced (Ferreira, 1991, 1993). Therefore it is assumed that the processing load continuously fluctuates during speech production (Power, 1985; Ford & Holmes, 1978) and that these fluctuations are correlated with variations in the frequency of stuttering. In the present experiment, a dual-task paradigm was used to investigate whether higher-level cognitive processing can induce speech disfluencies and how persons who stutter differ from persons who do not stutter with respect to frequency of inhalation and speech rate (Bosshardt, 1997). Under dual-task conditions, an automatic word repetition task had to be performed concurrently with mental addition as a secondary task. In the oral word-repetition task, participants were required to continuously repeat a sequence of three words until the experimenter stopped them after the 10th repetition.

Speaking under dual-task conditions has already been studied in stuttering research (Arends, Povel, & Kolk, 1988; Brutten & Trotter, 1985, 1986; Kamhi & McOsker, 1982; Mallard & Webb, 1980; Sussman, 1982; Thompson, 1985). Mallard and Webb found that irregular changes of the room illumination and presentation of irrelevant speech noise did not significantly affect speech fluency. Similarly, Kamhi and McOsker (1982) found that a nonattention-demanding gross-motor task also had no effect on speech fluency. As an attention-demanding task, pursuit tracking requires continuous sensory-motor coordination. Thompson (1985) did not find that tracking as a secondary task produced significant changes in stuttering rate; however, with more complex speech tasks, Arends et al. (1988) found that pursuit tracking affects speech fluency. In particular, they found that in spontaneous speech production the number and duration of disfluencies was significantly smaller when this task had to be performed concurrently with tracking.

From the theory of multiple resources as proposed by Wickens (1984; see also Wieland-Eckelmann, 1992), it can be deduced that the degree to which speech fluency is affected by a secondary task depends on the extent to which both tasks draw on the same processing resources. In the present investigation overt word repetition and mental calculation were chosen as dual tasks because on the background of the existing evidence (Baddeley, 1997; Baddeley, Eldridge, & Lewis, 1981; Gathercole & Baddeley 1993) it can be assumed that both tasks demand resources from the central executive and phonological loop systems. Presumably, continuous word repetition can essentially be seen as a product of the phonological loop and of the articulatory systems with minimal demands on the central executive, whereas conversely the mental addition task is largely based on central executive processes (Hitch, 1978). In mental calculation, the phonological system is only involved insofar as provisional results are stored in it. The central executive is a limited-capacity system which is responsible for the control of mental processes and short-term retention with one strategy for the latter being use of the phonological loop for the storage of provisional results.