

Grant code GSTUA2

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Introduction

Performance costs (i.e., reductions in speed and accuracy) occur as a result of performing two tasks at the same time (i.e., dual-task performance). A large literature exists on exploring the nature of the underlying mechanisms associated with dual-task interference and ultimately, how such interference can be minimized (Allport, Antonis, & Reynolds, 1972; Hazeltine, et. al., 2006; Welford, 1952). More recently, researchers have targeted the influence of dual-task performance on speech production (Dromey & Shim, 2008; Maner, Smith, & Grayson, 2000). The intent of the present study was to evaluate the influence of practice on a variety of measures of single and dual-task performance. We hypothesize that reaction time, error rate and lip-jaw kinematics will equalize with practice to a point where these variables for the single-task will not differ from the dual-task. Such a finding would support the AEC framework, whereas, significant differences among the variables for the tasks would support the CCB framework.

Methods:

Participants

The study included 8 healthy adults without a history of speech, language, hearing or neurological deficits.

Instrumentation

Lip and jaw movements were acquired using a head-mounted strain gauge system (Barlow, Cole & Abbs, 1983). Movement and acoustic signals were digitized, filtered and differentiated through the use of Powerlab.

Procedures

This experiment consisted of an Auditory-Verbal (AV) stimuli-response task involving the association of three auditory tones (100, 1000, & 3000 Hz) and three spoken bilabial words (Pineapple, Blueberry, & Persimmon). For the pure AV condition, when a specific tone was heard, the participant produced the associated word as quickly and accurately as possible. The second stimuli-response task, the Visual-Manual (VM) task, involve the association of three visual symbols (--P--, **B**, & ~~P~~) present on the computer screen to three corresponding to a keystrokes (1, 2, & 3). For the pure VM condition, one of the visual symbols appeared on the computer screen, the participant as quickly and accurately as possible would press the associated key on the keyboard. The stimulus-response pairs were adopted because they are hypothesized to exhibit limited shared cognitive processes and therefore, limited interference. (Shumacher et al., 2001). For the dual-task condition, the participants were presented the two tasks simultaneously and were instructed to perform each task as quickly and accurately as possible regardless of whatever else happened on a trial, and not to constrain the serial order of their responses. The control of the presentation, calculation of reactions and error rate will be completed through the E-Prime software system. Five experimental sessions were conducted for each participant based on the methodology set forth by Schumacher and colleagues (2001).

Data Analysis

A repeated measures analysis of variance (ANOVA), with main effects of task and session was completed. The dependent variables included RT, error rate, duration, STI, velocity, and displacement.

Results

Reaction Time and Error Rates

- RTs & ERs were significantly greater for AV conditions compared to VM conditions.
- RTs & ERs were significantly greater for dual-task conditions compared to single-task conditions.
- RTs decreased significantly from the original pre-practice testing compared to the post-practice testing for both single- and dual-tasks where ER increased.
- After practice, the RTs for single- and dual-tasks did not equalize (i.e., within 100 ms) (however, individual participant data indicated equalization for two individuals).

Comparison of Kinematic Movements for Two Differing Frameworks

Based on RT data Subject 1 followed the CCB hypothesis and Subject 2 followed the AEC hypothesis. As noted, only the opening movement descriptive statistics are provided because no differences were observed for the closing movements for all kinematic variables.

Discussion

Results of our study suggest that dual-task performance is limited by the CCB hypothesis based on the RT findings. Throughout dual-task performance, mean RTs for the AV task and/or the VM task exceeded the mean RTs of the single-task trials by 100 ms or more (Schumacher, et. al 2001). In order for the results to demonstrate consistent minimal dual-task costs or near-perfect time sharing, at least one of the tasks must have a very short response time (e.g., under 300 ms), which are participants did not achieve (Hazeltine, et. al. 2006). Therefore, the present results indicate support for the CCB in that one response must be selected before another may begin.

Six out of the eight participants confirmed the view of CCB and only two of the eight participants achieved near-perfect time sharing to support the AEC hypothesis of equalized task performance. These results are consistent with previous findings, however, there are many factors to consider when examining interference during dual-task performance (e.g., emphasis on priority of tasks, type of speech task, resource allocation, etc.) (Schumacher, et. al 2001; Dromey & Bates, 2005).

Overall error rates were significantly greater for post-testing compared to pre-testing for both single- and dual-task conditions which suggests a trade-off in accuracy with increased speed, even though the participants were instructed to be both fast and accurate. Interestingly when looking at individual data, ERs were greatest in the post-test for two individuals who equalized RT thus suggesting an emphasis on speed over accuracy.

Kinematics were not influenced by task or by practice, however, some different patterns emerged when examining individual participant data. One of the individuals who

equalized RT between single- and dual-task conditions displayed different kinematic patterns than an individual who did not equalize RT. Therefore, it appears that during practice speakers may be influenced by cognitive strategies and personal preferences (e.g., focus on the speed or the accuracy of completing a task) when learning to perform dual-tasks, even at the kinematic level.

Use of Funds:

The grant money went toward paying incentives to the subjects to enhance performance and financially support an hourly student worker to run the experiments and complete aspects of data analysis.