The Effect of Cognitive Load on Discourse Fluency in Women with TBI

Introduction

Each year, approximately 125,000 individuals in the United States sustain a traumatic brain injury (TBI) from which they are expected to have life-long disability (Selassie et al., 2008). Social communication deficits are common (Coelho, 1995) in individuals with TBI, and contribute to negative social outcomes (Galski, Tompkins, & Johnston, 1998; Struchen et al., 2008). Though social communication deficits after TBI are well characterized (Coelho, 1995), the underlying neurpsychological mechanisms of these deficits remain unclear. One neuropsychological deficit that has been linked to social communication impairments in the TBI literature is executive dysfunction (Channon & Watts, 2003; Coelho, Liles, & Duffy, 1995; Douglas, 2010), yet it is unclear whether this relationship is correlational (e.g., brain injury affects both social communication and executive functioning) or causal (e.g. executive dysfunction causes poor social communication). To address this knowledge gap, the aim of this study was to characterize the relationship of executive dysfunction to social communication by manipulating the executive function (EF) demands of a discourse task and investigating the effects of this manipulation on discourse performance. Participants were women with and without TBI. Women were chosen for this investigation because they are frequently under-represented in TBI research, in part to their lower risk for TBI (Faul, Xu, Wald, & Coronado) and also because there is evidence of sex-based differences in social communication outcomes following TBI (Dahlberg et al., 2006; Turkstra). The study focused on one aspect of discourse performance that might be affected by EF demand, discourse fluency.

Method

Five women with moderate to severe TBI were compared to five women without TBI matched for age and educational level. All participants spoke English as their first language and had no history of learning disability, speech or language services, or psychiatric diagnosis (prior to injury for the TBI group), per participant report. In addition, participants with TBI were required to have an Aphasia Quotient on the Western Aphasia Battery (Kertesz, 1982) of at least 93.8 to ensure oral language skills sufficient for the study tasks (Kertesz, 1982).

Each participant engaged in a five-minute "warm-up" conversation with the first author to allow participants to become familiar with the environment and accommodate to the video camera. At the end of the warm-up conversation, participants were asked to discuss their opinions about five controversial social topics (e.g., global warming legislation, assisted suicide). For each topic, the participant read a short informational paragraph about the issue and answered three content questions to ensure comprehension. After answering the comprehension questions, participants were asked why they felt the issue was a good or a bad thing (low-EF condition). When the participant indicated that she had concluded her comments about an issue, she was asked to repeat the task without using the words *and* or *the* (high-EF condition). Topic order was randomized across participants.

Discourse samples were orthographically transcribed using CHAT coding conventions (MacWhinney, 2000) and segmented into terminable units (t-units) (Coelho, Grela, Corso, Gamble, & Feinn, 2005). The rate of dysfluency for each participant was calculated by dividing the number of total maze behaviors (filled pauses, revisions, repetitions, reformulations, or

unintelligible utterances) across all topics in a condition by the total number of t-units within a condition (i.e., total mazes/total t-units).

As a measure of EFs, participants also completed the *Color-Word Interference Test* (CWIT) from the Delis-Kaplan Executive Function Systems (Delis, Kaplan, & Kramer, 2001), which is a measure of verbal inhibitory control (Delis et al., 2001).

Hypotheses and Statistical Analysis

It was hypothesized that 1) women with and without TBI would be less fluent in conditions with higher EF demands (i.e., have more dysfluencies), and 2) increasing the EF demand would have a greater effect on fluency in the TBI group relative to the comparison group (CG). Fluency data were compared between groups using t-tests.

Results

As a group, participants' fluency did not differ significantly across EF conditions ($t = 1.08$, $p = .31$). As a group, participants tended to be more fluent in the high-EF condition as compared to in the low-EF condition. Additionally, the TBI and CG did not differ significantly in their degree of fluency change from the low-to high conditions ($t = .09$, $p = .55$) suggesting that fluency of participants in the TBI and CG was similarly affected by the change in executive demand across discourse conditions. To explore whether the observed within-group variability in performance across conditions might be related to EFs, Spearman rank-order correlations were performed between standard scores on the CWIT and frequency of dysfluent behavior in the low- and high-EF conditions of the discourse task. This analysis revealed a moderate negative correlation in the high-EF condition ($\rho = -.52$) and a modest correlation between rate of dysfluency and CWIT scores for the low-EF condition ($\rho = -.21$).

Discussion

The aim of this study was to investigate the effect of EF demands on discourse performance of women with TBI. The hypotheses that high EF demands would result in more discourse dysfluency, especially in women with TBI, were not supported. Instead, increased EF demands seemed to affect the two groups similarly, as fluency increased with EF demand, perhaps by focusing participants on their language production. It should be noted that a large degree of individual variability was observed. Within the TBI group, three participants became less fluent as EF demand increased while the other two participants became more fluent. By contrast, in the control group, three participants demonstrated improved fluency, while one became more dysfluent and one had consistent performance across conditions. The variability could be explained in part by EF ability, given the correlation between EF test scores and dysfluency, especially in the high-EF condition. The findings suggest that verbal inhibition ability is linked to the ability to produce fluent discourse, particularly in the face of high cognitive demand. While the results of this preliminary study must be interpreted with caution due to the small sample size, they provide early evidence that EF abilities may affect social communication performance, particularly in situations that impose high cognitive demands. If replicated, this finding may be important both clinically and in research, as it reinforces work by previous authors who have highlighted the importance of considering cognitive demands imposed by discourse assessment and elicitation tasks (Le, Coelho, Mozeiko, Krueger, & Grafman, 2012; Van Leer & Turkstra, 1999).

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Table 1. Participant Demographics

Participant ID	Age	Level of Education	Injury Mechanism	Aphasia Quotient
TBI1	56	Bachelor's degree and some graduate studies	MVA	97.4
TBI2	23	Bachelor's degree	MVA	98.6
TBI3	31	Bachelor's degree	MVA	96.1
TBI4	33	Associates degree	Pedestrian vs. MVA	99.6
TBI5	33	Bachelor's degree	Sledding Accident	99.6
CG1	27	Bachelor's degree and some graduate studies		
CG2	26	Bachelor's degree		
CG3	28	Bachelor's degree		
CG4	29	Associates degree		
CG5	29	Masters degree		

MVA = motor vehicle accident