Relation of Executive Functioning to Pragmatic Outcome Following Severe Traumatic Brain Injury

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Purpose: This study was designed to explore the behavioral nature of pragmatic impairment following severe traumatic brain injury (TBI) and to evaluate the contribution of executive skills to the experience of pragmatic difficulties after TBI.
Method: Participants were grouped into 43 TBI dyads (TBI adults and close relatives) and 43 control dyads. All TBI participants had sustained severe injury (mean posttraumatic amnesia duration = 45.19 days, *SD* = 39.15) due to a moving vehicle-related trauma. A minimum of 2 years had elapsed since injury (*M* = 5.36 years, *SD* = 3.61). The La Trobe Communication Questionnaire (LCQ; Douglas, O'Flaherty, & Snow, 2000) was administered to all participants. Measures of executive function included the following: the FAS verbal fluency task (Spreen & Benton, 1969), the Speed and Capacity of Language Processing test (Baddeley, Emslie, & Nimmo-Smith, 1992), and the Rey Auditory Verbal Learning Task (Rey, 1964).
Results: Perceptions of TBI participants and their relatives were significantly correlated ($r = .63$, $p < .001$) and significantly different from those of controls, $F(1, 84) = 37.2$, $p < .001$. Pragmatic difficulties represented violations in 3 domains of Grice's (1975) Cooperative Principle (Quantity, Relation, and Manner), and executive function measures predicted 37% (32% adjusted) of the variability in LCQ scores.
Conclusions: The study demonstrates evidence of a significant association between executive impairment and the pragmatic communication difficulties experienced by individuals with TBI.

KEY WORDS: traumatic brain injury, pragmatics, executive function

Impaired communication skills are a well-established consequence of severe traumatic brain injury (TBI). Deficits range from motor speech impairment (Goozee, Murdoch, Theodoros, & Stokes, 2000; Jaeger, Hertrich, Stattrop, Schonle, & Ackerman, 2000; Wang, Kent, Duffy, & Thomas, 2005) to impaired word finding (Bittner & Crowe, 2006; Hoofien, Gilboa, Vakil, & Donovick, 2001; Kerr, 1995; Olver, Ponsford, & Curran, 1996) and impaired pragmatic ability (Channon & Watts, 2003; McDonald, 1993; Snow, Douglas, & Ponsford, 1997, 1998; Turkstra, McDonald, & Kaufmann, 1995). Pragmatic skills have been defined as "the skills underlying competence in contextually determined, functional language use" (Turkstra et al., 1995, p. 329). Although Turkstra et al.'s (1995) definition of pragmatic skills is applicable from a functional perspective, Body and Perkins (2006) have pointed out considerable variability with respect to current conceptualizations of the fundamental nature of pragmatics as a field of study. For example, Perkins (1998, 2005) has described pragmatic ability and disability as emergent phenomena viewed as "the emergent consequence of interactions between linguistic, cognitive, and sensorimotor processes which take place both within and between individuals" (Perkins, 2005, p. 367). In contrast, Joanette and Ansaldo (1999) have argued that pragmatic ability should be considered as essentially a linguistic rather than cognitive process—that is, "part of language" (p. 529) in the same way as syntax. D. Wilson (2005) has argued yet another perspective and has conceptualized pragmatics as a submodule of a central cognitive "dedicated inferential module" (p. 1129) or mind-reading module.

The specific manifestations of TBI-related pragmatic impairment include difficulties in meeting the informational needs of the listener (McDonald, 1993; Snow et al., 1997, 1998), lack of logical structure and coherence in discourse (Liles, Coelho, Duffy, & Zalagens, 1989; O'Flaherty & Douglas, 1997), difficulty with implied meaning (McDonald, 1992; O'Flaherty & Douglas, 1997), inappropriate choice of conversational content/topic (Togher, Hand, & Code, 1997; Snow et al., 1997), inappropriate style of interaction (McDonald & van Sommers, 1993; O'Flaherty & Douglas, 1997), inappropriate change in topic/tangentiality (Bracy & Douglas, 2005), and impoverished content (Snow et al., 1997, 1998; Stout, Yorkston, & Pimentel, 2000). The consequences of such deficits are that conversations with adults with TBI are frequently hard to follow, disconcerting, and uncomfortable (Bracy & Douglas, 2005; Coelho, Youse, & Le, 2002), with increased dependence on the communication partner to maintain the flow of conversation (Coelho et al., 2002; Togher et al., 1997).

Many researchers in the field of TBI have conceptualized these pragmatic deficits as reflecting the impact of cognitive impairments on relatively intact linguistic function (Body, Perkins, & McDonald, 1999; Bracy & Douglas, 2005; Douglas, 2004; Godfrey & Shum, 2000; Hagen, 1984; Hartley, 1995; Martin & McDonald, 2003; McDonald, 1993; Ylvisaker, Szekeres, & Feeney, 2001). Particular attention has been paid to the role of executive dysfunction (Channon & Watts, 2003; Coelho, 2002; Douglas, Bracy, & Snow, 2007a; Martin & McDonald, 2003; McDonald & Pearce, 1998; Snow et al., 1998) and memory (Hartley & Jensen, 1991; Youse & Coelho, 2005). Executive functions can be described as cognitive control processes that include self-regulation, allocation of attention, maintenance and manipulation of information over time, planning, and task management (Grafman & Litvan, 1999; Miller, 2000; Rolls, 1999; van Zomeren & van den Burg, 1985). These control processes encompass diverse capacities relevant to pragmatic function, such as initiating and maintaining goals, inhibiting irrelevant or inappropriate responses, structuring and monitoring task performance, and appreciating multiple perspectives in a situation. Executive functions also enable the efficient deployment of specific skills, such as word retrieval or verbal fluency (Miller, 2000). Deficits may manifest as impaired attention, psychomotor slowing, poor response inhibition, distractibility, initiation difficulties, reduced flexibility, impaired memory performance, and difficulties modifying behaviors based on prior experience (Baddeley, 1998; Busch, McBride, Curtiss, & Vanderploeg, 2005; Muscovitch & Winocur, 2002; Stuss & Alexander, 2005; Stuss & Benson, 1986). All of these deficits have the potential to impact negatively on the functional use of language in social contexts.

Currently, there is no single model or classification scheme that explains the range of cognitive abilities encompassed within the executive function system (Busch et al., 2005; Kim et al., 2005; Miyake et al., 2000). Similarly, there is no single "gold standard" measure of executive function identified in the literature. Although there is no general consensus regarding models or measures of executive functions, it is widely accepted that the prefrontal cortex and its circuitry mediate these functions (Miller, 2000). Consequently, a variety of measures of frontal lobe abilities have been used to measure executive function capacities (Boone, Ponton, Gorsuch, Gonzalez, & Miller, 1998; Busch et al., 2005; Kim et al., 2005). The prefrontal cortex is particularly vulnerable as a result of the neuropathology of TBI (Adams, Graham, Scott, Parker, & Doyle, 1980; Blumbergs, Jones, & North, 1989; Levin & Kraus, 1994). In fact, impaired executive function is widely considered to be among the hallmark deficits encountered by those who sustain TBI (Kim et al., 2005; Mattson & Levin, 1990; Millis et al., 2001). Thus, it is not surprising that researchers have suggested that pragmatic impairments associated with TBI reflect at least in part impairments in executive functioning. Despite this suggestion, a review of the literature indicates that there continues to be relatively little research that has directly investigated the relation between executive function, as measured by neuropsychological tests, and pragmatic communication following TBI in adults.

Studies that have explored associations between executive control processes and pragmatic impairment in this population are outlined in Table 1. Two of these seven studies focused only on components of memory function (Hartley & Jensen; 1991; Youse & Coelho, 2005). Various neuropsychological tests considered sensitive to frontal lobe damage have been used. Subtests of the Wechsler Memory Scale (WMS; Wechsler, 1945), the Rey Auditory Verbal Learning Task (RAVLT; Rey, 1964), and the Telephone Search While Counting task (TSWC) from the Test of Everyday Attention (Robertson, Ward, Ridgeway, & Nimmo-Smith, 1994) have been used as measures of working memory or the ability to maintain and manipulate information over time. The Wisconsin Card Sorting Test (WCST; Heaton, Chelune, Talley, Kay, & Curtiss, 1993) has been used to evaluate multiple aspects of executive function, including concept formation, rule discovery, and the ability to shift cognitive set and to inhibit impulsive responding. Inhibition has also

Table 1. Direct investigation of associations between executive/control processes and pragmatic impairment after severe traumatic brain injury (TBI) in adults.

Author(s) (year)	*n*	Injury severity	Time postinjury	Executive function measures	Pragmatic tasks	Pragmatic measures	Magnitude of significant correlations (*r*)
Hartley and Jensen (1991)	11	Coma length = 5–90 days	31–616 days	WMS subtests: Digit Span (DS) and Logical Memory (LM)	Story retelling, story generation, and procedural description	Productivity (Quantity) = six measures; Content (Quality) = three measures; Cohesion	Productivity (total words): LM = .74, DS = .73; Content (target): LM = .89, DS = .68; Cohesion: LM = .79; DS = .60
Coelho et al. (1995)	32	Not provided	2–19 months	WCST (Perseverative factor)	Story retelling and story generation	Sentence production, cohesive adequacy, and story structure	Story structure: Perseverative factor = .51
McDonald and Pearce (1998)	15	Not provided	3 months–10 years	WCST, COWAT, and RAVLT performance categories: Conceptual, Perseveration, and Disinhibition	Request production task	Number and type of strategy produced	Total number of strategies: Disinhibition = .46
Snow et al. (1998)	24	≥14 days PTA	≥2 years (range = 2–3.5 years)	FAS TMT (Part B), RAVLT, and SCOLP	Conversation	Modified Clinical Discourse Analysis (CDA): Total errors	FAS = −.41; TMT (Part B) = .49; RAVLT = −.35
Coelho (2002)	55	LOC range = 0–99 days	Range = 1–99 months	WCST (Cards, Categories, Perseverations, and Errors)	Story retelling and story generation	Sentence production (words/T-unit, subordinate clauses/T-unit), cohesive adequacy (complete/total ties), and story grammar (total episodes, T-units episode)	Story grammar (total episodes): Cards = −.30; Perseverative = −.28; Errors = −.29
Channon and Watts (2003)	15	PTA range = from 1 day to >4 weeks	≥1 year	TSWC, Hayling test, and SET	Contextual meaning task	Sensitivity	Hayling test error scores (*p* = .021)
Youse and Coelho (2005)	55	LOC range = 0–99 days	Range = 1–99 months	WMS subtests: DS, LM, and Associative Learning (AL)	Story retelling and story generation	Sentence production (words/T-unit, subordinate clauses/T-unit), cohesive adequacy (complete/total ties), and story grammar (total episodes, T-units episode)	DS: subclauses/T-unit = .30; AL: words/T-unit = .29; cohesive adequacy = .34; story grammar (total episodes) = .36

Note. WCST = Wisconsin Card Sorting Test; COWAT = Controlled Oral Word Association Test; RAVLT = Rey Auditory Verbal Learning Task; PTA = posttraumatic amnesia; TMT = Trail Making Test; SCOLP = Speed and Capacity of Language Processing test; LOC = loss of consciousness; TSWC = Telephone Search While Counting task; SET = Six Elements Test; WMS = Wechsler Memory Scale.

been assessed using the Hayling test (Burgess & Shallice, 1996) and the Controlled Oral Word Association Test (COWAT) or FAS verbal fluency task (Spreen & Benton, 1969). In addition, the FAS task is considered to provide an index of cognitive flexibility and initiation. The Trail Making Test (TMT; Reitan & Wolfson, 1985) Part B measures mental flexibility and divided attention. The Six Elements Test (SET) of the Behavioural Assessment of the Dysexecutive Syndrome (B. Wilson, Alderman, Burgess, Emslie, & Evans, 1996) assesses the ability to multitask, and the Speed and Capacity of Language Processing test (SCOLP; Baddeley, Emslie, & Nimmo-Smith, 1992) provides an index of speed of processing verbal material. Similarly, a variety of measures of pragmatic function have been used, ranging from tasks designed to examine pragmatic comprehension of contextual meaning (Channon & Watts, 2003) to detailed analysis of discourse samples (Hartley & Jensen, 1991; Snow et al., 1998; Youse & Coelho, 2005) derived from differing elicitation procedures (story retelling, story generation, structured conversation, and procedural description).

As well as variability in the measures used, there are considerable differences in the sample size and injury-related characteristics of participants that may have influenced the findings reported in these studies. Although all the studies included adults with severe injury, some sampled a very broad range across the severity continuum (Channon & Watts, 2003; Coelho, 2002; Youse & Coelho, 2005). Inclusion criteria for injury chronicity also vary markedly within this group of studies. Snow et al. (1998) assessed participants between a defined time postinjury range of 2–3.5 years to sample a relatively stable pragmatic profile. In contrast, participants in Coelho's studies (e.g., Coelho, 2002; Youse & Coelho, 2005) were assessed as early as 1 month to as late as 8.25 years after injury. Finally, small sample size with associated compromised power for correlation analyses as well as multiple analyses without adjustments to alpha level combine to reduce the overall strength of the findings reported. For example, Youse and Coehlo (2005) computed a total of 30 bivariate correlations between discourse and memory measures to identify four significant correlations. Similarly, Hartley and Jensen (1991) computed at least 54 exploratory correlations on a small sample of 11 participants. Notwithstanding these limitations, these studies together provide some evidence of a significant association between executive function and pragmatic ability following severe TBI. However, the magnitude of the association is relatively small, accounting for substantially less than 25% of variance in pragmatic function in most studies.

The proposal that executive control processes exert a substantial influence on pragmatic function is intuitively appealing, and it is surprising to find only relatively weak support for it in these empirical findings. It is possible that choice of pragmatic measures has played a role in shaping these findings. Indeed, Channon and Watts (2003) suggested using measures, such as the La Trobe Communication Questionnaire[1] (LCQ; Douglas, O'Flaherty, & Snow, 2000), to assess directly the extent of pragmatic communication difficulties experienced by individuals with TBI. Such an approach allows for behavioral description and measurement of the problems encountered by adults with TBI as they negotiate day-to-day interactions in the community. In contrast, most traditional pragmatic evaluations are completed on discourse samples elicited in structured, artificial settings. As a result, the deficits identified clinically may not reflect the type and frequency of deficits noted by persons with TBI (Snow & Douglas, 2000). Reports of real-life experience of pragmatic impairment may well provide a more sensitive measure with which to explore the potential relationship between executive and pragmatic dysfunction. For this reason, pragmatic difficulties were measured in the present study from the perspective of individuals with TBI and those with whom they interact regularly. Further, these perceptions were compared with a control group of adults matched for age, gender, and education.

The use of self-report in the TBI population, however, does not come without its challenges. Important among these challenges from a measurement perspective is the impact of impaired self-awareness on self-report. This is particularly the case when awareness of deficit may itself be compromised as a result of the neurological damage sustained. Significant underestimation of problems or denial of deficits on self-report has been reported frequently in the TBI literature (Cavallo, Kay, & Ezrachi, 1992; Ehrlich & Barry, 1989; Fordyce & Roueche, 1986; McNeill-Brown & Douglas, 1997; Prigatano, 1991, 2005). However, results do not always reflect a clear picture of underestimation of disability or reduced self-awareness (Goldstein & McCue, 1995), and several authors have reported finding not only individuals who underreport their problems but also those who overreport their deficits (Bracy & Douglas, 2005; Chelune, Heaton, & Lehman, 1986; Pagulayan, Temkin, Machamer, & Dikman, 2007; Prigatano & Altman, 1990). Further, there is evidence to suggest that greater awareness of deficits may develop with the passage of time and repeated experience of difficulty in daily living situations (Godfrey, Partridge, Knight, & Bishara, 1993; Pagulayan et al., 2007; Prigatano, 1999, 2005). Although measurement of awareness continues to be a focus of ongoing research (Pagulayan et al., 2007), concordance between the perception of the person with TBI and the perception of a

[1]The La Trobe Communication Questionnaire is available for clinical and research use from the author.

close other is currently the most commonly applied method to measure the phenomenon (Fleming, Strong, & Ashton, 1996; Prigatano, 2005). Thus, obtaining both self- and close-other data afforded the opportunity of gauging broadly the level of self-awareness in the current group of participants.

Overall, this study was conceptualized with two aims in mind. The first was to describe the behavioral nature of pragmatic communication deficits as experienced by adults with severe TBI living in the community more than 2 years after injury. To meet this first aim, pragmatic difficulties reported by adults with severe TBI and their relatives were compared with those of a control group matched for age, gender, and years of education. At the same time, reports of those with TBI and their relatives were compared to identify potential differences that might reflect compromised self-awareness. Two hypotheses were proposed: (a) the nature and frequency of difficulties reported by TBI participants and their relatives would be similar, and (b) TBI participants and their relatives would report significantly more frequent problems than control participants and their relatives.

The second aim was to investigate the contribution of executive skills to the experience of pragmatic difficulties reported by adults with severe TBI. In the context of the second aim, it was hypothesized that performance on measures sensitive to cognitive control processes would make significant and unique contributions to the prediction of self-reported pragmatic difficulties in everyday situations. Specifically, poorer performance on measures of executive function was expected to be associated significantly with more frequent experience of pragmatic deficits.

Method

Participants

Participants were recruited for two groups: a TBI group and a control group. All participants were required to have completed the majority of their schooling in an English-speaking country, and people with a past history of hearing, neurological, or psychiatric disability were excluded from the study. The TBI group involved 43 dyads comprising an adult with severe TBI (mean duration of posttraumatic amnesia [PTA] = 45.19 days, SD = 39.15) and a close relative. Participants with TBI were volunteers sourced from several rehabilitation and community disability services in Melbourne, Australia. Demographic and injury-related characteristics of TBI participants are provided in Table 2. TBI participants were required to have sustained a single severe, nonpenetrating brain injury resulting in loss of consciousness and PTA of at least 14 days. Brain cat scan or magnetic resonance imaging results were available on 34 of the 43 participants and are shown in Table 2. The minimum injury severity criterion of 14 days PTA was chosen to ensure that participants had all sustained injuries clearly within the severe range. Further, the findings of contemporary outcome studies indicate that PTA of 2 weeks is a more appropriate cutoff for defining severe TBI than earlier defined periods of 24 hr or 7 days (Ponsford, Sloan, & Snow, 1995; van Zomeren & van den Burg, 1985).

The majority of TBI participants were male (35 men, 8 women). All had sustained their injuries as a result of moving vehicle-related trauma and were at least 18 years of age at the time of injury (M = 32.93 years, SD = 11.37). A minimum of 2 years had elapsed since the injury (M = 5.36 years, SD = 3.61), and all participants were living in the community. The minimum period of 2 years since the injury was imposed to ensure that participants had reached a relatively stable level of disability with respect to communication outcome and to maximize the likelihood that participants were relatively aware of their own functional abilities. No TBI participant displayed clinical evidence of motor speech disturbance, receptive aphasia, or expressive aphasia, and none of the participants were currently receiving speech pathology intervention.

An equal number of dyads were recruited from the community to a normative control group. Participants for the control group were matched with TBI participants for age, education, and gender. The following guidelines were used for matching participants: Individuals were directly matched for gender, individuals were matched within ±3 years of age, and individuals were matched within ±1 year for years of education. Average age for control participants was 37.86 years (SD = 12.82) compared with the average age of 38.60 years (SD = 12.91) for TBI participants at the time of interview. Years of education for both groups were similar (control: M = 12.47 years, SD = 1.97; TBI: M = 12.74 years, SD = 2.36). The TBI and control groups were exactly matched on gender composition (35 men and 8 women). They were not significantly different in age (t = –0.595, p = .553) or years of education (t = 0.268, p = .789).

Each participant invited an adult relative (≥21 years of age) with whom he/she resided to participate in the study. Relationships represented by relatives in the TBI dyads included 21 wives, four husbands, 10 mothers, four fathers, three sisters, and one brother. In the control dyads, relationships were similar and included 23 wives, four husbands, nine mothers, three fathers, two sisters, and two brothers.

Materials

Level of functioning. The 1987 revision of the Disability Rating Scale (DRS; Rappaport, Hall, Hopkins, Belleza, & Cope, 1982; Rappaport, Herrero-Backe, Rappaport, & Winterfield, 1989) was used to assess

Table 2. Demographics, injury-related characteristics, and raw scores on all measures for TBI participants (n = 43).

Participant	Gender	Age at injury (years)	Age at assessment (years)	PTA (days)	Initial CT/ MRI findings	TPI (years)	DRS (total)	LCQ– Form S (total)	LCQ– Form O (total)	FAS (total)	RAVLT (total)	SCOLP (total)
1	M	31	33	49	L subdural hematoma	2.6	1	46	73	48	48	65
2	M	57	62	21	L parietal hemorrhage	5	3	44	47	48	54	30
3	M	38	49	21	Information not available	11	1	48	46	42	47	40
4	M	36	51	42	Information not available	15	4	67	50	34	31	51
5	M	52	55	56	L subdural hematoma	3	6	70	94	19	40	30
6	M	31	35	49	Global contusion	4.1	2	40	50	35	60	87
7	M	26	35	106	L temporal extradural hematoma	9.1	2	60	56	42	48	40
8	M	38	43	56	Cerebral edema	4.3	2	67	69	31	44	66
9	F	35	38	14	NAD	2.8	1	31	37	45	44	64
10	M	20	23	35	NAD	3	4	63	46	26	67	25
11	M	24	37	28	Information not available	3.1	4	38	45	50	47	40
12	M	25	28	14	Blood in third, fourth, and lateral ventricles	3	1	45	43	37	31	37
13	F	22	26	35	Global contusion	3.3	2	72	62	55	45	40
14	M	23	25	83	Bilateral posterior temporal lobe contusion	2.1	4	48	50	35	29	24
15	F	25	27	35	NAD	2	2	86	90	16	41	30
16	M	19	21	48	NAD	2	2	44	65	41	36	21
17	M	32	34	35	R temporal extradural hematoma; L temporal contusion	2.1	2	54	37	41	47	21
18	F	18	20	21	Fractured base of skull	2.4	1	68	70	35	45	87
19	F	19	22	28	Cerebral edema	2.7	4	78	91	39	49	40
20	F	24	27	21	R subdural hematoma; L frontal contusions	2.5	3	61	57	21	37	30
21	M	22	25	28	R temporal extradural hematoma; deep R cerebral contusion	2.6	2	44	34	33	44	38
22	M	22	24	21	R parietal hemorrhage and cerebral contusion	2.7	2	70	40	19	40	18
23	F	39	42	28	R occipital horn hemorrhage	3	2	61	56	41	45	50
24	M	20	23	28	NAD	2.8	2	90	74	27	37	24
25	F	18	21	35	R frontal contusion	3.5	1	71	57	44	60	42
26	M	47	51	14	Intraventricular blood	4.2	6	84	93	24	37	40
27	M	42	44	21	L frontal contusion	2.6	1	91	70	24	36	21
28	M	31	46	30	Information not available	15	4	47	55	30	41	47
29	M	28	34	63	R temporal hemorrhage	5	4	75	70	24	36	39
30	M	30	42	42	Information not available	12	2	57	38	47	47	40
31	M	59	69	18	Information not available	10	4	54	73	45	46	64
32	M	48	53	21	Intraventricular blood	4	1	61	48	30	39	47
33	M	47	54	150	Information not available	7	4	74	79	35	29	24
34	M	48	53	40	R frontal contusion	5	4	66	69	31	44	38
35	M	40	48	49	L temporo-parietal contusion and hematoma	8	2	80	75	19	28	24
36	M	39	48	105	Information not available	9	7	38	68	48	53	66
37	M	28	34	24	Cerebral edema	6	4	59	66	24	37	30
38	M	24	29	225	R subdural hematoma; L frontal contusions	5	8	50	55	35	43	38
39	M	42	56	56	Information not available	13	4	59	73	30	39	47
40	M	54	61	55	L temporo-parietal and R parietal contusions	7	3	46	68	48	53	42
41	M	33	40	42	Cerebral edema	7	1	46	38	39	51	40

(Continued on the following page)

Table 2 *Continued.* Demographics, injury-related characteristics, and raw scores on all measures for TBI participants (*n* = 43).

Participant	Gender	Age at injury (years)	Age at assessment (years)	PTA (days)	Initial CT/ MRI findings	TPI (years)	DRS (total)	LCQ–Form S (total)	LCQ–Form O (total)	FAS (total)	RAVLT (total)	SCOLP (total)
42	M	33	36	37	R temporal extradural hematoma	3	6	76	74	24	36	39
43	M	28	36	14	NAD	8	2	38	43	31	64	50
M		32.93	38.60	45.19		5.36	2.95	59.70	60.33	34.70	43.61	41.30
SD		11.37	12.91	39.15		3.61	1.76	15.51	16.37	9.96	9.05	16.39

Note. CT = computerized tomography; MRI = magnetic resonance imaging; TPI = time postinjury; DRS = Disability Rating Scale; LCQ = La Trobe Communication Questionnaire; Form S = self-report form; Form O = close other/relative form; M = male; F = female; L = left; R = right; NAD = no abnormality detected.

quantitatively the current level of functioning of TBI participants. The DRS is considered to provide a reliable and valid global rating of functional level following TBI (Eliason & Topp, 1984; Fleming & Maas, 1994; Gouvier, Blanton, LaPorte, & Nepomuceno, 1987; Hall, Hamilton, Gordon, & Zasler, 1993; Rappaport, 2005) and has been used widely to evaluate functional outcome (e.g., Bell et al., 2005; Cifu et al., 1996; Douglas & Spellacy, 2000; Rappaport et al., 1989).

The DRS consists of eight items divided into four categories: (a) arousability, awareness, and responsivity; (b) cognitive ability for self-care activities; (c) dependence on others; and (d) psychosocial adaptability. A total score can be calculated by adding the scores on the eight items. The following clinical levels of disability were proposed by the authors of the scale: 0 = *none*, 1 = *mild,* 2–3 = *partial,* 4–6 = *moderate,* 7–11 = *moderately severe,* 12–16 = *severe,* 17–21 = *extremely severe,* 22–24 = *vegetative state,* and 25–29 = *extreme vegetative state*. Ratings in the present study were based on direct observation as well as interviews with TBI participants and their close others in the home environment.

Pragmatic ability. The LCQ (Douglas et al., 2000) was administered independently to individual participants within the TBI and control dyads. The LCQ consists of two forms: Form S (self-report form) and Form O (close other/relative form). The forms are identical in content, with the exception that Form O uses the third person when describing communication behaviors. There are 30 items on the LCQ. Item content reflects the four domains of Grice's (1975) Cooperative Principle of conversation—Quantity, Quality, Relation, and Manner—supplemented by items reflecting pragmatic deficits reported in relevant TBI literature (e.g., Coelho, Liles, & Duffy, 1995; Hagen, 1984; Hartley & Jensen, 1991; Hartley & Levin, 1990). Example items from the LCQ in each of Grice's categories and the TBI specific category are provided in Table 3 (for a more detailed description of item content, see Douglas, Bracy, & Snow, 2007b; Douglas et al., 2000).

There are four possible levels of response for each of the 30 items: 1 = *never or rarely,* 2 = *sometimes*, 3 = *often,* and 4 = *usually or always*. The frequency response format yields individual item scores ranging from 1 to 4 and a total score ranging from 30 to 120. High scores are consistent with a perception of frequent difficulties, and low scores indicate less frequent difficulties.

The LCQ has been psychometrically evaluated on young healthy adults (Douglas et al., 2000) and adults with TBI (Douglas et al., 2007b). It was found to have

Table 3. Maxims of Grice's (1975) Cooperative Principle of conversation and TBI-related content with example items from the LCQ.

Domain	Example LCQ Items
Quantity: amount of information to be provided (for the current purposes of the exchange)	1. Leave out important details 25. Carry on talking about things for too long
Quality: truth of information	28. Give information that is completely accurate 15. Give people information that is not correct
Relation: relevance of information	20. Give answers not connected to the question
Manner: how what is said is to be said—be perspicuous	7. Have difficulty thinking of the particular word 2. Use a lot of vague or empty words 11. Know when to talk and when to listen 23. Put ideas together in a logical way
TBI-related	29. Lose track of conversations in noisy places 27. Answer without taking time to think about what the other person has said

high internal consistency (self-report: Cronbach's α = .85; close others: Cronbach's α = .86) and to have acceptable stability over time for self-report (test–retest reliability at 8 weeks: r = .76) in the healthy adult population. Similarly, internal consistency of the questionnaire was high for TBI participants (Cronbach's α = .91) and their close others (Cronbach's α = .92). Test–retest coefficients across a 2-week interval for TBI participants (r = .81) and their close others (r = .87) were also acceptable. Principal component factor analysis supports the construct validity of the LCQ and indicates that it can also be used to measure dimensions within TBI-related cognitive-communicative breakdown: inhibitory and attention control in conversation, conversational fluency, and conversational task management (Douglas et al., 2007a).

Douglas et al. (2000) provided LCQ normative data for the perceptions of 147 healthy adults and 109 close others. Total LCQ scores for self- and close-other reports in the normative group were normally distributed around a total score mean of 52.47 (*SD* = 9.62) for self-report ratings and a mean of 47.17 (*SD* = 9.93) for close-other ratings.

Executive function. Three measures were selected to evaluate executive control processes in the verbal domain. Each of these measures had been used previously by researchers to evaluate the contribution of executive function to pragmatic ability following TBI (see Table 1).

The COWAT or FAS verbal fluency task (Spreen & Benton, 1969) was used to provide an index of inhibition, cognitive flexibility, and task management. The test evaluates the spontaneous production of single words within a limited amount of time. In the FAS task, participants have 1 min to produce orally as many words as possible under a restricted search condition defined by the first letter of the word (F, A, and S). Thus, the task requires efficient deployment of word retrieval skills, and its completion taps into a range of executive functions, including self-regulation, allocation of attention, planning, and task management. The validity of the FAS task as a measure of frontal lobe function has been supported by the findings of numerous research studies (Lezak, 2004; Spreen & Strauss, 1998). The score used for analysis in the current study was the total number of words provided across the three letters. Normative data reported by Spreen and Strauss (1998) show a total score mean of 40.5 (*SD* = 10.7) for adults in the age range of 16–59 years.

The RAVLT (Rey, 1964; Spreen & Strauss, 1998) was used as a measure of the ability to maintain and manipulate information over time. The RAVLT is a brief easily administered measure of new learning/memory performance. It was chosen as a measure for this study in an attempt to replicate previous findings in the literature (Hartley & Jensen, 1991; McDonald & Pearce, 1998; Snow et al., 1998) and as an index of the role of the frontal cortex in managing storage and processing functions (Muscovitch & Winocur, 2002; Stuss & Alexander, 2005; Stuss et al., 1994). The score entered for analysis was the total number of words recalled over five trials. Ivnik et al. (1990) provided adult normative data for the total number of words recalled over five trials and reported a mean of 53.2 (*SD* = 8.2) in the age range of 55–59 years.

The third measure was the Speed of Comprehension (silly sentences) subtest of the SCOLP (Baddeley et al., 1992). It was used to provide an index of speed of verbal information processing or the *efficiency* of language comprehension. The test is considered to provide a speeded measure of fluid performance rather than a measure of crystallized language performance (Baddeley et al., 1992). Efficiency of processing is particularly vulnerable to TBI (Tromp & Mulder, 1991) and has been implicated by previous researchers as playing a negative role in discourse behavior following brain injury (Godfrey, Knight, Marsh, Moroney, & Bishara, 1989; Snow et al., 1998). In this test, participants are asked to verify (true/false) a list of statements about the world as quickly as they possibly can. The score analyzed in the current study was the total number of statements correctly verified in 2 min. Carstairs, Myors, Shores, and Fogarty (2006) reported a mean of 63.63 (*SD* = 16.63) on the Speed of Comprehension total score of the SCOLP for healthy adult participants.

Procedure

All participants were seen in their homes for data collection, and the session began with completion of informed consent procedures. TBI participants completed the LCQ in an interview format with the researcher, whereas TBI relatives and control participants were given the option of completing it in either an interview or in a written questionnaire form. In the interview format, the questionnaire requires approximately 30 min to complete. Completion of the written questionnaire requires 15 min. Measures of executive function were administered in a random order to each TBI participant after completion of the LCQ. The DRS was completed by the investigator at the end of each visit. All procedures were approved by the Faculty of Health Sciences Human Ethics Committee, La Trobe University (Victoria, Australia).

Data Analysis

Nonparametric analyses (Mann–Whitney U test and Wilcoxon signed-ranks test) were used for analyses comparing the TBI and control group data for two reasons. First, the homogeneity of variance assumption for parametric tests was not met for comparison of the control and TBI groups. Second, the item response format for individual items yields ordinal, not ratio, data. An alpha level of .01 was applied to all group comparison tests on composite scores (total scores and subscores). A Bonferroni-adjusted alpha level was used for comparisons of individual items.

Pearson correlation coefficients (r) and the coefficient of determination (r^2) were calculated to evaluate the direction and magnitude of associations between variables. Two-tailed tests of significance with an alpha level of .05 were applied for nondirectional analyses, and one-tailed tests and the same alpha level were applied to analyses supported by directional hypotheses. Standard multiple regression analysis was used to evaluate the variance (R^2 and adjusted R^2) in pragmatic function (LCQ total score) accounted for by the executive function measures (FAS total score, RAVLT five-trial total, and SCOLP Speed of Comprehension total score—all entered individually).

Minimum sample size for this study was set at 41 TBI participants. The calculation was based on the multiple regression analysis to enable detection of a relatively large effect size ($f^2 = 0.3$) given an alpha level of .05, statistical power of .80, and three predictors in the regression equation.

Results

Disability ratings on the DRS and raw scores on the LCQ, FAS, RAVLT, and SCOLP for the TBI participants are presented in Table 2. Descriptive statistics for the LCQ total score and Gricean domain subscores for TBI and control dyads are shown in Table 4.

Level of Function

Disability ratings for the TBI participants show that none had escaped some level of long-term disability. Restricted employability was characteristic of all the participants; in most cases, the restriction was primarily a result of cognitive and/or behavioral, rather than physical, dysfunction. Overall, nine participants were rated as having mild disability, 17 were rated as having partial disability, 15 were rated as having moderate disability, and two were rated as having moderate-to-severe disability at the time of the study.

Comparing the Perceptions of TBI Participants and Relatives

Inspection of LCQ total scores reported by the TBI participants and their relatives (see Table 2) shows that 95.34% (n = 41) of the group reported total scores that reflected, on average, a difference of less than 1 point on the 4-point item rating scale (i.e., less than 30 points on the total score) of the LCQ; 69.77% (n = 30) differed overall by less than half a point on the 4-point item rating scale (i.e., less than 15 points on the total score). The difference was not always in the same direction. For six of the 13 dyads who recorded total scores that differed by more than 15 points, the difference was consistent with relatives perceiving more frequent difficulties; for seven dyads, the difference was consistent with TBI participants perceiving more frequent difficulties.

Wilcoxon signed-ranks tests (two-tailed) were used to compare statistically the total scores and Gricean domain subscores reported by the TBI participants and their relatives. There were no significant differences

Table 4. Descriptive statistics on LCQ total and Gricean domain scores of TBI and control groups (n = 86).

	TBI		Control	
Score type	Self	Relative	Self	Relative
LCQ total				
M (*SD*)	59.70 (15.51)	60.33 (16.37)	48.42 (9.58)	41.21 (8.27)
Range	31–91	34–94	30–69	30–61
Quantity				
M (*SD*)	8.37 (2.80)	8.95 (2.76)	6.65 (1.48)	6.00 (1.77)
Range	4–14	4–15	4–10	4–11
Quality				
M (*SD*)	4.67 (1.67)	5.35 (1.89)	4.32 (1.12)	4.16 (1.25)
Range	3–9	3–9	3–7	3–7
Relation				
M (*SD*)	10.16 (3.15)	10.21 (2.91)	8.09 (2.15)	6.79 (1.81)
Range	5–17	5–16	5–12	5–11
Manner				
M (*SD*)	17.00 (4.59)	16.91 (4.98)	13.65 (3.00)	11.67 (2.80)
Range	9–25	9–28	9–22	9–20

between the scores generated by the TBI participants and their relatives on any of these measures (LCQ total score: $Z = -0.302$, $p = .763$; Quantity: $Z = -1.304$, $p = .301$; Quality: $Z = -2.280$, $p = .023$; Relation: $Z = -0.051$, $p = .959$; Manner: $Z = -0.162$, $p = .871$). There was, however, a trend toward relatives reporting significantly more frequent problems in the Quality domain. Total LCQ scores of TBI participants and their relatives were significantly correlated ($r = .63$, $p < .0001$), as were the subscores on each of the Gricean domains: Quantity ($r = .47$, $p = .001$), Quality ($r = .46$, $p = .001$), Relation ($r = .44$, $p = .002$), and Manner ($r = .57$, $p < .0001$).

Potential differences on specific behaviors between the self-report of TBI participants and their relatives' reports were investigated using Wilcoxon signed-ranks tests (two-tailed) on individual items. A Bonferroni-adjusted alpha level of .0017 (0.5/30 items) was set prior to running these comparisons. However, no significant differences were revealed on any of the items using either the Bonferroni-adjusted alpha level or the more liberal .01 level. Comparisons on five items yielded test statistics commensurate with significance levels between .01 and .10 (Item 7 [word-finding problems]: $Z = -1.757$, $p = .079$; Item 8 [slow rate]: $Z = -2.547$, $p = .011$; Item 15 [incorrect information]: $Z = -1.755$, $p = .079$; Item 18 [difficulty starting conversations]: $Z = -2.503$, $p = .012$; Item 22 [rapid rate]: $Z = -2.459$, $p = .014$; Item 30 [difficulty closing conversations]: $Z = -1.781$, $p = .075$). An additional three comparisons yielded test statistics commensurate with significance levels between .10 and .20 (Item 1 [leaving out important details]: $Z = -1.623$, $p = .105$; Item 16 [nonfluency]: $Z = -1.587$, $p = .112$; Item 28 [inaccurate information]: $Z = -1.620$, $p = .105$). Significance levels of tests statistics on all other remaining comparisons exceeded .20 and ranged from $p = .234$ to $p = 1.000$.

To further compare TBI participants' and relatives' perspectives in the TBI group, individual items were ranked with respect to average frequency of difficulty reported with the behaviors. The top-10 rankings for both the TBI participants and their relatives are shown in Table 5. Items with the same average frequency of difficulty rating were allocated the same ranking. This procedure resulted in 11 items being assigned top-10 ranking for the TBI participants and 17 items assigned top-10 ranking from the relatives' perspective. There was considerable similarity between the rankings. Ten of the 11 items in the top rankings for the TBI participants were also in the top rankings of the relatives. The only item that was not in the relatives' top 10 was in fact ranked 11th. Similarly, the additional six items that fell in the top rankings for relatives were ranked 11–16

Table 5. Items with the top-10 frequency of difficulty rankings from TBI participants and their relatives.

LCQ item	Gricean domain	LCQ factor	Self-report mean frequency	Relative mean frequency	Self-report item ranking	Relative item ranking
7. Thinking of the particular word	Manner	Conversational Fluency	2.70	2.47	1	2
29. Tracking of conversations in noisy places		Attentional Control	2.67	2.58	2	1
12. Get sidetracked by irrelevant parts of conversation	Relation	Attentional Control	2.40	2.33	3	4
10. Hesitate, pause, or repeat	Manner	Conversational Fluency	2.35	2.30	4	5
13. Hard to follow group conversations		Attentional Control	2.30	2.33	5	4
5. Need a long time to think before answering	Manner	Conversational Fluency	2.23	2.16	6	8
19. Keeping track of main details		Task Management	2.21	2.02	7	10
3. Go over and over the same ground	Quantity	Inhibitory Control	2.19	2.35	8	3
25. Carry on talking about things too long	Quantity	Inhibitory Control	2.14	2.21	9	6
26. Thinking of things to say to keep conversation going	Relation	Attentional Control	2.14	2.00	9	(11)
21. Change speech style according to the situation	Relation	Task Management	2.13	2.33	10	4
2. Use a lot of vague/empty words	Quantity	Conversational Fluency	2.07	2.21	(13)	6
9. Say/do things others consider rude/embarrassing	Relation	Inhibitory Control	2.09	2.19	(12)	7
1. Leave out important details	Quantity	Conversational Fluency	1.98	2.19	(15)	7
27. Answer without taking time to think		Inhibitory Control	2.07	2.16	(13)	8
11. Know when to talk and when to listen	Manner	Task Management	1.91	2.09	(16)	9
4. Switch to a different topic too quickly	Relation	Inhibitory Control	2.12	2.02	(11)	10

Note. Values in parentheses indicate ranked levels outside top 10.

in the self-report data. The Quantity domain was the only domain that showed a consistent pattern in assigned rankings; these behaviors all received lower self-report rankings when compared with relatives' rankings.

Comparing the TBI and Control Groups

A two-tailed Mann–Whitney U test was used to assess whether there was a significant difference between the self-report scores of TBI and control participants. Overall, total scores indicated that TBI participants reported significantly more difficulties than did the control participants ($U = 533.50$, $p = .001$). Similarly, relatives of TBI participants reported significantly higher total scores than relatives of controls ($U = 283.50$, $p < .0001$). On Gricean domain subscores, TBI participants self-reported significantly more difficulties than the control participants in the Quantity ($U = 609$, $p = .006$), Relation ($U = 558.50$, $p = .001$), and Manner ($U = 508.50$, $p < .0001$) domains; however, they did not report significantly more difficulties than the control participants in the Quality ($U = 867$, $p = .607$) domain. Relatives of TBI participants reported significantly higher total scores than relatives of controls in all four domains: Quantity ($U = 364$, $p < .0001$), Quality ($U = 592$, $p = .003$), Relation ($U = 308$, $p < .0001$), and Manner ($U = 338$, $p < .0001$).

Two-tailed Mann–Whitney U tests were then applied to those individual items that had received top-10 rankings with respect to average frequency of difficulty as perceived by TBI participants and their relatives (see Table 6). Given that 11 items were assigned top rankings for the TBI participants and 17 items for the relatives, the alpha level was adjusted for multiple comparisons using the Bonferroni procedure. An adjusted alpha level of .005 (.05/11) was applied to the self-report comparisons and .003 (.05/17) to the relatives' comparisons between the TBI and control groups. Results indicate that TBI participants reported significantly more frequent difficulties than did the control participants on six of 11 items: Item 7 ($U = 486.5$, $p < .0001$), Item 12 ($U = 562.5$, $p = .001$), Item 13 ($U = 481.5$, $p < .0001$), Item 5 ($U = 541.5$, $p < .0001$), Item 19 ($U = 593$, $p = .002$), and Item 3 ($U = 606$, $p = .003$). TBI relatives reported significantly more frequent difficulties than the control relatives on 17/17 top-ranked items ($p < .003$). Indeed, there were only six items that did not show significant differences between TBI and control groups on either self-report or relatives' scores. These items included the following: Item 6 ("Find it hard to look at the other speaker"; Manner domain), Item 17 ("Trouble using tone of voice"; Manner domain), Item 18 ("Difficulty getting conversations started"; Quantity domain), Item 22 ("Speak too quickly"; Manner domain), Item 24 ("Allow people to assume wrong impressions"; Quality domain), and Item 28 ("Give information that is completely accurate"; Quality domain).

Table 6. Comparison of mean ratings from control participants on items with the top-10 frequency of difficulty rankings from TBI participants and their relatives.

			Self-report		Relative report	
LCQ item	Gricean domain	LCQ factor	TBI mean frequency	Control mean frequency	TBI mean frequency	Control mean frequency
7. Thinking of the particular word	Manner	Conversational Fluency	2.70[a]	1.98	2.47[b]	1.42
29. Tracking of conversations in noisy places		Attentional Control	2.67	2.14	2.58[b]	1.77
12. Get sidetracked by irrelevant parts of conversation	Relation	Attentional Control	2.40[a]	1.74	2.33[b]	1.51
10. Hesitate, pause, or repeat	Manner	Conversational Fluency	2.35	1.84	2.30[b]	1.44
13. Hard to follow group conversations		Attentional Control	2.30[a]	1.47	2.33[b]	1.26
5. Need a long time to think before answering	Manner	Conversational Fluency	2.23[a]	1.54	2.16[b]	1.37
19. Keeping track of main details		Task Management	2.21[a]	1.65	2.02[b]	1.42
3. Go over and over the same ground	Quantity	Inhibitory Control	2.19[a]	1.62	2.35[b]	1.42
25. Carry on talking about things too long	Quantity	Inhibitory Control	2.14	1.70	2.21[b]	1.49
26. Thinking of things to say to keep conversation going	Relation	Attentional Control	2.14	1.88	2.00[b]	1.35
21. Change speech style according to the situation	Relation	Task Management	2.13	1.65	2.33[b]	1.51
2. Use a lot of vague/empty words	Quantity	Conversational Fluency	2.07	1.67	2.21[b]	1.65
9. Say/do things others consider rude/embarrassing	Relation	Inhibitory Control	2.09	1.63	2.19[b]	1.42
1. Leave out important details	Quantity	Conversational Fluency	1.98	1.65	2.19[b]	1.44
27. Answer without taking time to think		Inhibitory Control	2.07	1.63	2.16[b]	1.44
11. Know when to talk and when to listen	Manner	Task Management	1.91	1.51	2.09[b]	1.30
4. Switch to a different topic too quickly	Relation	Inhibitory Control	2.12	1.67	2.02[b]	1.33

[a]Mann–Whitney U TBI self-report versus control self-report ($p < .005$). [b]Mann–Whitney U TBI relative report versus control relative report ($p < .003$).

The Nature of Long-Term Pragmatic Difficulties

Tables 5 and 6 present the Gricean and LCQ factor domains of the behaviors that were identified as problematic by TBI participants and their relatives as well as being significantly more frequent in occurrence for those with TBI when compared with matched controls. These chronic conversational difficulties represented violations in three of the four domains of Grice's (1975) Cooperative Principle (Quantity, Relation, and Manner), and all four factors of the LCQ were represented.

Associations Between Pragmatic Difficulties and Measures of Executive Function

Prior to evaluating associations between pragmatic difficulties and measures of executive function, correlations with demographic and injury-related variables were calculated (see Table 7). None of the correlations between LCQ self-report or executive function scores and age (at injury and assessment), length of PTA, time postinjury, and disability rating reached significance.

All three of the executive function measures yielded significant bivariate correlations with LCQ total scores (FAS: $r = -.568$, $p < .001$, $r^2 = .323$; RAVLT: $r = -.388$, $p = .005$, $r^2 = .151$; SCOLP: $r = -.353$, $p = .01$, $r^2 = .125$). Given that significant correlations were revealed between the measures of executive function and LCQ total scores, correlations between executive function measures and Gricean domains and LCQ factors were computed to enable exploration of potential patterns within the correlations. A more stringent .01 alpha level was applied to these correlations presented in Table 8.

Correlations between FAS verbal fluency scores and total scores for each of the Gricean domains and LCQ factors were all significant. Scores on the RAVLT correlated significantly with scores on Grice's (1975) Relation domain and the Conversational Fluency and Attentional Control factors of the LCQ. SCOLP scores did not yield significant correlations with any of the domain or factor scores.

To assess the contribution of executive function deficits to pragmatic impairment, standard regression analysis was performed after screening for outliers and adherence with the assumptions of multivariate analyses. Table 9 shows bivariate correlations between the variables included in the regression equation; unstandardized (B) and standardized (β) regression coefficients; the semipartial correlations (sr^2); and R, R^2, and adjusted R^2. For regression of scores on the three executive function measures on LCQ total score, R was significantly different from zero, $F(3, 39) = 7.63$, $p < .001$. In this equation, the three executive function measures predicted 37% (32% adjusted) of the variability in LCQ scores. This R^2 value is consistent with a large effect ($f^2 = 0.59$). Only the FAS score yielded a regression coefficient that differed significantly from zero ($p = .003$), indicating that 16% of the variance in LCQ total scores was attributable to the FAS as a unique source. The RAVLT and SCOLP scores did not make significant unique contributions to

Table 8. Correlations between measures of executive function and Gricean domains and LCQ factors ($n = 43$).

	Executive function measures					
	FAS		RAVLT		SCOLP	
LCQ subscore	*r*	*p*	*r*	*p*	*r*	*p*
Gricean domains						
Quantity	**–.55**	**< .001**	–.35	.01	–.24	.06
Quality	**–.50**	**< .001**	–.22	.08	–.19	.12
Relation	**–.38**	**.008**	**–.38**	**.006**	–.34	.01
Manner	**–.59**	**< .001**	–.34	.01	–.34	.01
Factors						
Inhibitory Control	**–.41**	**.003**	–.23	.07	–.23	.07
Conversational Fluency	**–.52**	**< .001**	**–.36**	**.009**	–.32	.02
Attentional Control	**–.43**	**.002**	**–.50**	**< .001**	–.33	.02
Task Management	**–.59**	**< .001**	–.34	.01	–.31	.02

Note. Significant correlations are shown in bold.

Table 7. Correlations of LCQ and executive function scores with demographic and injury-related variables.

	Age at injury		Age at assessment		PTA		TPI		DRS	
Variable	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
LCQ–self total	–.02	.45	–.09	.29	–.06	.70	–.18	.26	.05	.73
FAS	.05	.77	.10	.51	.08	.60	.13	.40	–.17	.27
RAVLT	–.08	.62	–.07	.66	–.11	.47	–.010	.95	–.12	.45
SCOLP	.09	.58	.14	.39	–.06	.73	.19	.23	–.09	.59

Table 9. Standard multiple regression of executive function measures on LCQ total scores for TBI participants (n = 43).

Variable	LCQ (DV)	FAS	RAVLT	SCOLP	*B*	β	sr^2
FAS	−0.57				−0.71*	−.46	.16
RAVLT	−0.39	0.40			−0.26	−.15	
SCOLP	−0.35	0.34	0.36		−0.13	−.14	
M	59.7	34.7	43.6	41.3			
SD	15.5	10	9.1	16.4			
R^2						37[a]	
Adj. R^2						.32	
R						.61**	

Note. DV = dependent variable; Adj. = adjusted.

[a]Unique variability = .16; shared variability = .21.

*p < .01. **p < .001.

the prediction of variability in LCQ total score. The three measures in combination accounted for another 21% of the variance.

Discussion

This study was undertaken to increase the understanding of the nature of chronic pragmatic impairment associated with severe TBI with particular reference to the role of executive function. Pragmatic function was measured from the perspective of those who had sustained the injury as well as those with whom they interacted regularly. Injured participants and their relatives were strikingly congruent with respect to their perceptions of problematic pragmatic behaviors. TBI participants experienced difficulties with the amount and the relevance of information that they provided in conversation as well as how they conducted the conversation. Those with whom they interacted perceived them to have the same difficulties. These results indicate that, at least in the longer term, the majority of adults with TBI have insight into their own conversational problems and are less likely to present with significantly impaired awareness of deficit. Across the entire group, only six of the 43 TBI participants reported substantially less frequent difficulties than did their relatives. Further, during administration of the LCQ, participants themselves often commented that they had come to recognize their conversational difficulties through experiencing numerous problems: "I say the wrong thing all the time"; "I just keep quiet … have no idea what they're on about"; "sometimes … too slow catching on."

Findings characterized by high concordance between self- and close-other reports are consistent with those reported by Bracy and Douglas (2005). Participants in Bracy and Douglas's study were 25 husbands who had sustained severe brain injuries a mean of 7.3 years earlier. Their perceptions on the LCQ were compared with those of their wives, and no significant differences were found for the group. In an earlier study that also used the LCQ to measure communication following severe TBI, McNeill-Brown and Douglas (1997) found that a group of 17 participants less than 1-year postinjury reported that they experienced significantly less frequent communication difficulties than were reported by either their close others or their rehabilitation workers. The results of these two studies, taken together with the current results, provide some support for the contention that self-awareness of communication difficulty increases with increasing time postinjury. This increased awareness may result from the combined effects of neurological recovery and accumulation of negative experiences in day-to-day conversational settings.

Overall, the Quality (as defined by Grice, 1975) of the conversational contribution of adults with severe brain injury did not present as a frequent long-term problem from the perspective of the individuals who sustained brain injury and those with whom they interacted regularly. In contrast, behaviors associated with violations of the conversational principles of Relation, Manner, and Quantity were clearly identified as creating frequent and chronic problems. A tendency for persistent disruption to occur in these aspects of conversational discourse after TBI has been reported previously. Snow et al. (1997, 1998) applied clinical discourse analysis (Damico, 1985) to the conversational samples of a group of severely injured TBI speakers between 3 and 6 months postinjury and then 2 years later. They too found that the majority of discourse errors made by TBI speakers occurred in the domains of Relation, Manner, and Quantity. Given that these three domains of conversation present enduring challenges for those with TBI, behavioral violations in these domains clearly require systematic treatment attention.

Contribution of Executive Deficits to Pragmatic Impairment

A significant proportion (approximately one third) of the variability in the pragmatic problems reported by TBI participants was accounted for by measures of executive function/dysfunction. Of the three executive function measures used, performance on the FAS was the only one to make a significant unique contribution to prediction of pragmatic impairment. In addition, the FAS verbal fluency task was also the only measure to yield significant associations with perceived difficulties in all the conversational domains described by Grice's (1975) universal principle as well as the factors of the LCQ. Snow et al. (1998) also found performance on the FAS task to correlate significantly with the number of discourse errors revealed by application of a modified clinical discourse analysis (Snow et al., 1997) to conversational samples elicited from 24 TBI participants. The fact that the FAS task gave rise to significant correlations is not surprising. The efficient deployment of specific word retrieval or verbal fluency skills clearly taps into a range of executive functions—including self-regulation, allocation of attention, planning, and task management—and it does so in the context of verbal material. Further, phonological fluency tasks, as exemplified by the FAS, are considered to be sensitive to frontal lobe damage (Lezak, 2004) and particularly sensitive to damage to the left dorsolateral prefrontal cortex (Stuss et al., 1998; Szatkowska, Grabowska, & Szymanska, 2000). In the phonological fluency paradigm exemplified by the FAS task, performance also requires suppression of the more usual meaning-based way of retrieving words and adoption of a retrieval strategy that relies on sound-based lexical representation (Szatkowska et al., 2000).

Previous researchers have also found significant associations between inhibitory control measures and pragmatic function after TBI. Channon and Watts (2003) used scores on three nonsocial executive tasks (Hayling test, SET, and TSWC) as predictors of pragmatic comprehension. These three predictors together gave rise to a significant regression equation accounting for 36% of the variance. However, the Hayling test error score, measuring inhibitory control, was the only measure that reached significance in the equation. Similarly, McDonald and Pearce (1998) reported a significant association between scores on a Disinhibition factor—derived from performance on the WCST, COWAT, and RAVLT—and the number of strategies elicited on a request production task.

Although a strong pattern of association emerged between performance on the FAS task and the LCQ, this was not the case for the processing speed/comprehension efficiency measure. Rate of information processing as indexed by the SCOLP did not yield significant correlations with perceived difficulties in any of the conversational domains described by Grice's (1975) universal principle or with any of the factors of the LCQ. This finding suggests that impaired processing speed may not have a substantial negative effect on everyday conversational experiences. Indeed, it may well be easier and more natural to use speaker and/or listener strategies to compensate for slowed processing rather than to compensate for task management or control deficits.

The pattern of association between the ability to maintain information over time (RAVLT performance) and pragmatic competence highlighted associations with Grice's (1975) Relation domain and the Conversational Fluency and Attentional Control factors of the LCQ. This finding provides evidence that impaired storage and retrieval processes contribute to problems of relevance, including topic management in conversation. Again, this result is not surprising given that several studies have shown that damage to the frontal lobes is associated with both encoding and retrieval deficits and impairment in the strategic control processes supporting memory (Alexander, Stuss & Fansabedian, 2003; Stuss & Alexander, 2005; Stuss et al., 1994; Wheeler, Stuss, & Tulving, 1995).

A possible explanation for the significant associations between executive and pragmatic function measures after TBI in the current and previous studies is that these associations simply reflect an underlying association with brain injury severity. In the present study, such an explanation is not supported, given that neither the LCQ scores nor the executive measure scores were correlated with duration of PTA—a sensitive and widely accepted measure of injury severity. Channon and Watts (2003) also reported a similar lack of association between severity of injury and task performance in their data. Although injury severity does not appear to have exerted a significant influence on the current findings, it must be acknowledged that associations between pragmatic and executive functions may be a consequence of the close proximity of the neuroanatomical substrates of the two functional systems rather than shared processes between the systems.

Although executive function—measured by three commonly used neuropsychological tests—was able to predict a significant proportion of the variability in pragmatic competence, a substantial proportion of variance in pragmatic behavior was left unexplained. Elucidation of the nature of this unexplained variance warrants further investigation. For example, there has been an increasing focus on the role that theory of mind (TOM)—the ability to attribute thoughts, emotions, and motivations to the minds of others—plays in pragmatic dysfunction after TBI (Bibby & McDonald, 2005). Indeed, Martin and McDonald (2003) considered both TOM and executive function in their discussion of explanatory models of pragmatic disorders, and Cummings (2005, 2007) recently has argued that TOM is the core cognitive skill involved in pragmatic function. Thus, an additional possible explanation for the significant associations in the current study is that they result from an underlying association with TOM ability.

Limitations

In this study, an effort was made to contribute further to the understanding of the relation between executive function and pragmatic impairment after TBI. Some of the methodological weaknesses of previous work in this area were addressed by focusing on those with strictly defined, severe injuries who were at least 2 years postinjury and thus likely to be experiencing relatively stable pragmatic and executive function. In addition, an effort was made to recruit enough participants to enable sufficient power for valid statistical testing of the relation between three measures of executive function and one measure of pragmatic ability. Nevertheless, the study has limitations. Executive function is a multifaceted construct. The executive function tools used in this study were few in number, limited to the verbal domain, and subject to their own measurement limitations. Further, the pragmatic measure involved self-report and, although substantial concordance between TBI participants and their close others was apparent, the results could have been strengthened by the addition of an objective measure of pragmatic function.

Conclusion

The present study demonstrates evidence of a significant association between executive impairment and the extent of pragmatic communication difficulties experienced by individuals with TBI. However, the strength of this association remains to be tested rigorously. There are many complexities involved with exploring the nature of pragmatic dysfunction after TBI, and continued systematic research directed by contemporary theoretical conceptualizations of pragmatics (e.g., Perkins, 2005; D. Wilson, 2005) is required.

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References

Adams, J., Graham, D., Scott, G., Parker, L., & Doyle, D. (1980). Brain damage in fatal on-missile head injury. *Journal of Clinical Pathology, 33,* 1132–1145.

Alexander, M., Stuss, D., & Fansabedian, N. (2003). California Verbal Learning Test: Performance by patients with focal frontal and non-frontal lesions. *Brain, 126,* 1493–1503.

Baddeley, A. (1998). The central executive: A concept and some misconceptions. *Journal of the International Neuropsychological Society, 4,* 523–526.

Baddeley, A., Emslie, H., & Nimmo-Smith, I. (1992). *The Speed and Capacity of Language Processing test*. Bury St. Edmunds, England: Thames Valley Test Company.

Bell, K. R., Temkin, N. R., Esselman, P. C., Doctor, J. N., Bombardier, C. H., Fraser, R. T., & Dikmen, S. (2005). The effect of a scheduled telephone intervention on outcome after moderate to severe traumatic brain injury: A randomized trial. *Archives of Physical Medicine and Rehabilitation, 86,* 851–856.

Bibby, H., & McDonald, S. (2005). Theory of mind after traumatic brain injury. *Neuropsychologia, 43,* 99–114.

Bittner, R., & Crowe, S. F. (2006). The relationship between working memory, processing speed and verbal comprehension and FAS performance following traumatic brain injury. *Brain Injury, 20,* 971–980.

Blumbergs, P., Jones, N., & North, J. (1989). Diffuse axonal injury in head trauma. *Journal of Neurology, Neurosurgery and Psychiatry, 52,* 838–841.

Body, R., & Perkins, M. (2006). Terminology and methodology in the assessment of cognitive-linguistic disorders. *Brain Impairment, 7,* 212–222.

Body, R., Perkins, M., & McDonald, S. (1999). Pragmatics, cognition and communication in traumatic brain injury. In S. McDonald, C. Code, & L. Togher (Eds.), *Communication in traumatic brain injury* (pp. 81–112). Sydney, Australia: Churchill Livingstone.

Boone, K., Ponton, M., Gorsuch, R., Gonzalez, J., & Miller, B. (1998). Factor analysis of four measures of prefrontal lobe functioning. *Archives of Clinical Neuropsychology, 13,* 585–595.

Bracy, C., & Douglas, J. (2005). Marital dyad perceptions of injured partners' communication following severe traumatic brain injury. *Brain Impairment, 6,* 1–12.

Burgess, P., & Shallice, T. (1996). Response suppression, initiation and strategy use following frontal lobe lesions. *Neuropsychologia, 34,* 263–273.

Busch, R., McBride, A., Curtiss, G., & Vanderploeg, R. (2005). The components of executive functioning in traumatic brain injury. *Journal of Clinical and Experimental Neuropsychology, 27,* 1022–1032.

Carstairs, J., Myors, B., Shores, A., & Fogarty, G. (2006). Influence of language background on tests of cognitive abilities. *Australian Psychologist, 41,* 48–54.

Cavallo, M., Kay, T., & Ezrachi, O. (1992). Problems and changes after traumatic brain injury: Differing perceptions within and between families. *Brain Injury, 6,* 327–335.

Channon, S., & Watts, M. (2003). Pragmatic language interpretation after closed head injury: Relationship to executive functioning. *Cognitive Neuropsychiatry, 8,* 243–260.

Chelune, G., Heaton, R., & Lehman, R. (1986). Relation of neuropsychological and personality test results to patients complaints of disability. In G. Goldstein & R. Tarter (Eds.), *Advances in clinical neuropsychology* (Vol. 3, pp. 95–126). New York, NY: Plenum Press.

Cifu, D., Kreutzer, J. S., Marwitz, J. H., Rosenthal, M., Englander, J., & High, W. (1996). Functional outcomes of older adults with traumatic brain injury: A prospective, multicenter analysis. *Archives of Physical Medicine and Rehabilitation, 77,* 883–888.

Coelho, C. A. (2002). Story narratives of adults with closed head injury and non-brain-injured adults: Influence of socioeconomic status, elicitation task, and executive functioning. *Journal of Speech, Language, and Hearing Research, 45,* 1232–1248.

Coelho, C., Liles, B., & Duffy, R. (1995). Impairment of discourse abilities and executive functions in traumatically brain injured adults. *Brain Injury, 9,* 471–477.

Coelho, C., Youse, K., & Le, K. (2002). Conversational discourse in closed head-injured and non-brain-injured adults. *Aphasiology, 16,* 659–672.

Cummings, L. (2005). *Pragmatics: A multidisciplinary perspective*. Edinburgh, Scotland: Edinburgh University Press.

Cummings, L. (2007). Pragmatics and adult language disorders: Past achievements and future directions. *Seminars in Speech and Language, 28,* 96–110.

Damico, J. S. (1985). Clinical discourse analysis: A functional approach to language assessment. In C. S. Simon (Ed.), *Communication skills and classroom success* (pp. 165–203). London, England: Taylor & Francis.

Douglas, J. (2004). The evidence base for the treatment of cognitive-communicative disorders following traumatic brain injury in adults. In S. Reilly, J. Douglas, & J. Oates (Eds.), *Evidence based practice issues in speech pathology* (pp. 59–82). London, England: Whurr.

Douglas, J., Bracy, C., & Snow, P. (2007a). Exploring the factor structure of the La Trobe Communication Questionnaire: Insights into the nature of communication deficits following traumatic brain injury. *Aphasiology, 21,* 1181–1194.

Douglas, J., Bracy, C., & Snow, P. (2007b). Measuring perceived communicative ability after traumatic brain injury: Reliability and validity of the La Trobe Communication Questionnaire. *Journal of Head Trauma Rehabilitation, 22,* 31–38.

Douglas, J. M., O'Flaherty, C. A., & Snow, P. (2000). Measuring perception of communicative ability: The development and evaluation of the La Trobe Communication Questionnaire. *Aphasiology, 14,* 251–268.

Douglas, J. M., & Spellacy, F. J. (2000). Correlates of depression in adults with severe traumatic brain injury and their carers. *Brain Injury, 14,* 71–88.

Ehrlich, J., & Barry, P. (1989). Rating communication behaviours in the head-injured adult. *Brain Injury, 3,* 193–198.

Eliason, M., & Topp, B. (1984). Predictive validity of Rappaport's Disability Rating Scale in subjects with acute brain dysfunction. *Physical Therapy, 64,* 1357–1360.

Fleming, J., & Maas, F. (1994). Prognosis of rehabilitation outcome in head injury using the Disability Rating Scale. *Archives of Physical Medicine and Rehabilitation, 75,* 156–163.

Fleming, J. M., Strong, J., & Ashton, R. (1996). Self-awareness of deficits in adults with traumatic brain injury: How best to measure? *Brain Injury, 10,* 1–15.

Fordyce, D., & Roueche, J. (1986). Changes in perspectives of disability among patients, staff and relatives during rehabilitation of brain injury. *Rehabilitation Psychology, 31,* 217–229.

Godfrey, H. P. D., Knight, R. G., Marsh, N. V., Moroney, B. M., & Bishara, S. N. (1989). Social interaction and speed of information processing following very severe closed head injury. *Psychological Medicine, 19,* 175–182.

Godfrey, H. P. D., Partridge, F. M., Knight, R. G., & Bishara, S. N. (1993). Course of insight disorder and emotional dysfunction following closed head injury: A controlled cross-sectional follow-up study. *Journal of Clinical and Experimental Neuropsychology, 15,* 530–515.

Godfrey, H. P. D., & Shum, D. (2000). Executive functioning and the application of social skills following traumatic brain injury. *Aphasiology, 14,* 433–444.

Goldstein, G., & McCue, M. (1995). Differences between patient and informant functional outcome ratings in head-injured individuals. *International Journal of Rehabilitation and Health, 1,* 25–35.

Goozee, J., Murdoch, B., Theodoros, D., & Stokes, P. (2000). Inematic analysis of tongue movements in dysarthria following traumatic brain injury using electromagnetic articulography. *Brain Injury, 14,* 153–174.

Gouvier, W. D., Blanton, P. D., LaPorte, K. K., & Nepomuceno, C. (1987). Reliability and validity of the Disability Rating Scale and the levels of cognitive functioning scale in monitoring recovery from severe head injury. *Archives of Physical Medicine and Rehabilitation, 68,* 94–97.

Grafman, J., & Litvan, I. (1999). Importance of deficits in executive function. *Lancet, 354,* 1921–1923.

Grice, P. (1975). Logic in conversation. In P. Cole & P. Morgan (Eds.), *Studies in syntax and semantics* (Vol. 3, pp. 41–58). New York, NY: Academic Press.

Hagen, C. (1984). Language disorder in head trauma. In A. Holland (Ed.), *Language disorders in adults* (pp. 245–281). San Diego, CA: College Hill Press.

Hall, K. M., Hamilton, B., Gordon, W. A., & Zasler, N. D. (1993). Characteristics and comparisons of functional assessment indices: Disability Rating Scale, functional independence measure and functional assessment measure. *Journal of Head Trauma Rehabilitation, 8,* 60–74.

Hartley, L. (1995). *Cognitive-communicative abilities following brain injury: A functional approach*. San Diego, CA: Singular.

Hartley, L., & Jensen, P. (1991). Narrative and procedural discourse after closed head injury. *Brain Injury, 5,* 267–285.

Hartley, L. L., & Levin, H. S. (1990). Linguistic deficits after closed head injury: A current appraisal. *Aphasiology, 4,* 353–370.

Heaton, R., Chelune, G., Talley, J., Kay, G., & Curtiss, G. (1993). *Wisconsin Card Sorting Test*. Odessa, FL: Psychological Assessment Resources.

Hoofien, D., Gilboa, A., Vakil, E., & Donovick, P. (2001). Traumatic brain injury 10–20 years later: A comprehensive outcome study of psychiatric symptomatology, cognitive abilities and psychosocial functioning. *Brain Injury, 15,* 189–209.

Ivnik, R., Malec, J., Tangalos, E., Petersen, R., Kokmen, E., & Kurland, L. (1990). The Auditory-Verbal Learning Test (AVLT): Norms for ages 55 years and older. *Psychological Assessment, 2,* 304–312.

Jaeger, M., Hertrich, I., Stattrop, U., Schonle, P., & Ackerman, H. (2000). Speech disorders following severe traumatic brain injury. *Folia Phoniatrica et Logopaedica, 52,* 187–196.

Joanette, Y., & Ansaldo, I. (1999). Acquired pragmatic impairments and aphasia. *Brain and Language, 68,* 524–534.

Kerr, C. (1995). Dysnomia following traumatic brain injury: An information processing approach to assessment. *Brain Injury, 9,* 777–796.

Kim, J., Whyte, J., Hart, T., Vaccaro, M., Polansky, M., & Coslett, H. (2005). Executive function as a predictor of inattentive behavior after traumatic brain injury. *Journal of the International Neuropsychological Society, 11,* 434–445.

Levin, H., & Kraus, M. (1994). The frontal lobes and traumatic brain injury. *Journal of Neuropsychiatry and Clinical Neurosciences, 6,* 443–454.

Lezak, M. (2004). *Neuropsychological assessment* (4th ed.). Oxford, England: Oxford University Press.

Liles, B., Coelho, C., Duffy, R., & Zalagens, M. (1989). Effects of elicitation procedures on the narratives of normal and closed head-injured adults. *Journal of Speech and Hearing Disorders, 54,* 356–366.

Martin, I., & McDonald, S. (2003). Weak coherence, no theory of mind, or executive dysfunction? Solving the puzzle of pragmatic language disorders. *Brain and Language, 85,* 451–466.

Mattson, A., & Levin, H. (1990). Frontal lobe dysfunction following closed head injury: A review of the literature. *Journal of Nervous and Mental Disease, 178,* 282–291.

McDonald, S. (1992). Differential pragmatic language loss following closed head injury: Ability to comprehend conversational implicature. *Applied Psycholinguistics, 13,* 295–312.

McDonald, S. (1993). Pragmatic language skills after closed head injury: Ability to meet the informational needs of the listener. *Brain and Language, 44,* 28–46.

McDonald, S., & Pearce, S. (1998). Requests that overcome listener reluctance: Impairment associated with executive dysfunction in brain injury. *Brain and Language, 61,* 88–104.

McDonald, S., & van Sommers, P. (1993). Pragmatic language skills alter closed head injury: Ability to negotiate requests. *Cognitive Neuropsychology, 10,* 297–315.

McNeill-Brown, D., & Douglas, J. (1997). Perceptions of communication skills in severely brain-injured adults. In J. Ponsford, V. Anderson, & P. Snow (Eds.), *International perspectives on traumatic brain injury: Proceedings of the Fifth International Association for the Study of Traumatic Brain Injury Conference* (pp. 247–250). Brisbane, Australia: Australian Academic Press.

Miller, E. (2000). The prefrontal cortex and cognitive control. *Nature Reviews Neuroscience, 1,* 59–65.

Millis, S., Rosenthal, M., Novack, T., Sherer, M., Nick, T., Kreutzer, J., & Ricker, J. (2001). Long term neuropsychological outcome after traumatic brain injury. *Journal of Head Trauma Rehabilitation, 16,* 343–355.

Miyake, A., Friedman, N., Emerson, M., Witzki, A., Howerter, A., & Wager, T. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology, 41,* 49–100.

Muscovitch, M., & Winocur, G. (2002). The frontal cortex and working with memory. In D. Stuss & R. Knight (Eds.), *Principles of frontal lobe function* (pp. 188–209). New York, NY: Oxford University Press.

O'Flaherty, C., & Douglas, J. (1997). Living with cognitive-communicative difficulties following traumatic brain injury: Using a model of interpersonal communication to characterise the subjective experience. *Aphasiology, 11,* 889–911.

Olver, J., Ponsford, J., & Curran, C. (1996). Outcome following traumatic brain injury: A comparison between two and five years after injury. *Brain Injury, 10,* 841–848.

Pagulayan, K., Temkin, N., Machamer, J., & Dikman, S. (2007). The measurement and magnitude of awareness difficulties after traumatic brain injury: A longitudinal study. *Journal of the International Neuropsychological Society, 13,* 561–570.

Perkins, M. (1998). Is pragmatics epiphenomenal? Evidence from communication disorders. *Journal of Pragmatics, 29,* 291–311.

Perkins, M. R. (2005). Pragmatic ability and disability as emergent phenomena. *Clinical Linguistics and Phonetics, 19,* 367–377.

Ponsford, J., Sloan, S., & Snow, P. (1995). *Traumatic brain injury: Rehabilitation for everyday adaptive living*. London, England: Erlbaum.

Prigatano, G. (1991). Disturbances of self-awareness of deficit after traumatic brain injury. In G. Prigatano & D. Schacter (Eds.), *Awareness of deficit after brain injury* (pp. 111–126). New York, NY: Oxford University Press.

Prigatano, G. (1999). *Principles of neuropsychological rehabilitation*. New York, NY: Oxford University Press.

Prigatano, G. (2005). Disturbances of self-awareness and rehabilitation of patients with brain injury: A 20-year perspective. *Journal of Head Trauma Rehabilitation, 20,* 19–29.

Prigatano, G. P., & Altman, I. M. (1990). Impaired awareness of behavioural limitations after brain injury. *Archives of Physical Medicine and Rehabilitation, 71,* 1058–1064.

Rappaport, M. (2005). The Disability Rating Scale and Coma/Near Coma Scales in evaluating severe head injury. *Neuropsychological Rehabilitation, 15,* 442–453.

Rappaport, M., Hall, K. M., Hopkins, H. K., Belleza, T., & Cope, D. N. (1982). Disability Rating Scale for severe head trauma: Coma to community. *Archives of Physical Medicine and Rehabilitation, 63,* 118–123.

Rappaport, M., Herrero-Backe, C., Rappaport, M. L., & Winterfield, K. (1989). Head injury outcome up to ten years later. *Archives of Physical Medicine and Rehabilitation, 70,* 885–892.

Reitan, R., & Wolfson, D. (1985). *The Halstead–Reitan Neuropsychological Test Battery*. Tucson, AZ: Neuropsychology Press.

Rey, A. (1964). *L'examen clinique en psychologie* [Clinical assessment in psychology]. Paris, France: Presses Universitaires de France.

Robertson, I., Ward, T., Ridgeway, V., & Nimmo-Smith, I. (1994). *The Test of Everyday Attention*. Suffolk, England: Thames Valley Test Company.

Rolls, E. (1999). The functions of the orbitofrontal cortex. *Neurocase, 5,* 301–312.

Snow, P. C., & Douglas, J. M. (2000). Conceptual and methodological challenges in discourse assessment with TBI speakers: Towards an understanding. *Brain Injury, 14,* 397–415.

Snow, P., Douglas, J., & Ponsford, J. (1997). Conversational assessment following traumatic brain injury: A comparison across two control groups. *Brain Injury, 11,* 409–430.

Snow, P., Douglas, J., & Ponsford, J. (1998). Conversational discourse abilities following severe traumatic brain injury: A longitudinal follow-up. *Brain Injury, 11,* 911–935.

Spreen, O., & Benton, A. (1969). *Neurosensory Centre Comprehensive Examination of Aphasia*. Victoria, British

Columbia, Canada: Neuropsychological Laboratory, Department of Psychology, University of Victoria.

Spreen, O., & Strauss, E. (1998). *A compendium of neuropsychological tests* (2nd ed.). New York, NY: Oxford University Press.

Stout, C., Yorkston, K., & Pimentel, J. (2000). Discourse production following mild, moderate and severe traumatic brain injury: A comparison of two tasks. *Journal of Medical Speech Language Pathology, 8,* 15–25.

Stuss, D., & Alexander, M. (2005). Does damage to the frontal lobes produce impairment in memory? *Current Directions in Psychological Science, 14,* 84–88.

Stuss, D., Alexander, M., Hamer, L., Palumbo, C., Dempster, R., Binns, M., & Izukava, D. (1998). The effects of focal anterior and posterior brain lesions on verbal fluency. *Journal of the International Neuropsychological Society, 4,* 265–278.

Stuss, D., Alexander, M., Palumbo, C., Buckle, L., Sayer, L., & Pogue, J. (1994). Organisational strategies of patients with unilateral or bilateral frontal lobe injury in word list learning tasks. *Neuropsychology, 8,* 355–373.

Stuss, D., & Benson, D. (1986). *The frontal lobes*. New York, NY: Raven Press.

Szatkowska, A., Grabowska, A., & Szymanska, O. (2000). Phonological and semantic fluencies are mediated by different regions of the prefrontal cortex. *Acta Neurobiologiae Experimentalis, 60,* 503–508.

Togher, L., Hand, L., & Code, C. (1997). Analysing discourse in the traumatic brain injury population: Telephone interactions with different communication partners. *Brain Injury, 11,* 169–189.

Tromp, E., & Mulder, T. (1991). Slowness of information processing after traumatic head injury. *Journal of Clinical and Experimental Neuropsychology, 13,* 821–830.

Turkstra, L., McDonald, S., & Kaufmann, P. (1995). Assessment of pragmatic communication skills in adolescents after traumatic brain injury. *Brain Injury, 10,* 319–345.

van Zomeren, A., & van den Burg, W. (1985). Residual complaints of patients two years after severe head injury. *Journal of Neurology, Neurosurgery and Psychiatry, 48,* 21–28.

Wang, Y., Kent, R., Duffy, J., & Thomas, J. (2005). Dysarthria in traumatic brain injury: A breath group and intonational analysis. *Folia Phoniatrica et Logopaedica, 57,* 59–89.

Wechsler, D. (1945). *Wechsler Memory Scale*. New York, NY: The Psychological Corporation.

Wheeler, M., Stuss, D., & Tulving, E. (1995). Frontal lobe damage produces episodic memory impairment. *Journal of the International Neuropsychological Society, 1,* 525–536.

Wilson, B., Alderman, N., Burgess, P., Emslie, H., & Evans, J. (1996). *Behavioural Assessment of the Dysexecutive Syndrome*. Bury St. Edmunds, England: Thames Valley Test Company.

Wilson, D. (2005). New directions for research on pragmatics and modularity. *Lingua, 115,* 1129–1146.

Ylvisaker, M., Szekeres, S., & Feeney, T. (2001). Communication disorders associated with traumatic brain injury. In R. Chapey (Ed.), *Language intervention strategies in aphasia and related neurogenic communication disorders* (pp. 745–808). New York, NY: Lippincott Williams & Wilkins.

Youse, K., & Coelho, C. (2005). Working memory and discourse production abilities following closed head injury. *Brain Injury, 19,* 1001–1009.

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