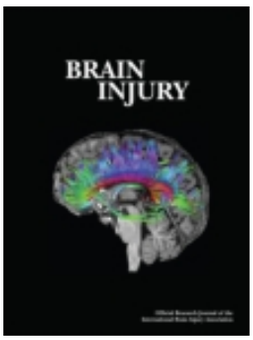

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Perceptions of communication abilities for persons with traumatic brain injury: Validity of the La Trobe Communication Questionnaire

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Abstract

Primary objective: To further evaluate the construct validity of the La Trobe Communication Questionnaire (LCQ) and to investigate the extent to which self-ratings of adults with traumatic brain injury compared to ratings made by close others and self-ratings made by non-injured matched controls.

Research design: Prospective cohort study.

Methods and procedures: Two hundred and seventy-six adults with TBI (121 of which are >1-year post-injury and previously enrolled in TBI Model Systems and 155 of which were consecutively admitted to a Level 1 trauma centre and were at least 6-months post-injury) completed the La Trobe Communication Questionnaire. In addition, for the TBI Model systems sample, 88 friends/family members and 80 non-injured matched controls participated.

Main outcomes and results: Principle components analysis with varimax rotation yielded four factors: Initiation/Conversational Flow, Disinhibition/Impulsivity, Conversational Effectiveness and Partner Sensitivity, which were found to have adequate internal consistency. Adequate discriminative validity was obtained in comparing adults with TBI to non-injured matched controls, while no significant differences were found between self-ratings of communication abilities by adults with TBI and those made by close others.

Conclusions: Additional support for the LCQ as a useful measure of perceived social communication abilities was obtained. Confirmatory factor analysis with a larger sample of adults with TBI will be a useful step in further development of this tool.

Keywords: *Traumatic brain injury, communication, assessment*

Introduction

Difficulty with social communication abilities is a common sequel for adults with moderate-to-severe traumatic brain injury (TBI) [1–3]. Social communication abilities include verbal and non-verbal communication skills that are applied within a social context. Impairments in social communication can include such problems as reduced initiation of conversation, problems with topic maintenance, tangentiality, over-talkativeness and slowed conversational rate. Communication difficulties can have a direct negative impact upon productivity and social integration, as well as an indirect impact on emotional functioning and quality of life [4–8]. Social communication competence plays a key role in the successful reintegration into home, work and school following TBI and is particularly important in the establishment of new friendships and the maintenance of personal relationships following injury [1, 2, 9, 10].

Despite the growing appreciation of the frequency and importance of social communication changes following TBI and the subsequent impact on

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psychosocial and functional outcomes, relatively few instruments are available that are dedicated solely to measuring social communication abilities [3, 11]. Interpersonal communication abilities have been most frequently measured via a single item or group of items contained on self- or other-report measures assessing numerous sequelae following TBI (e.g. Neurobehavioural Rating Scale [12], Neurobehavioural Functioning Inventory [13], Mayo-Portland Adaptability Scale [14], Patient Competency Rating Scale [15] and the Awareness Questionnaire [16]). While these provide at least some information about social communication status, the information obtained is at a fairly superficial level and does not lend itself well to the development of treatment targets. That is, these scales address communication abilities with only one or a few general items related to communication abilities. To identify specific areas of communication ability that might be addressed in an intervention, items ideally would identify specific aspects of communication skill (e.g. taking turns, initiating conversation, maintaining topic, etc.).

To the authors' knowledge, only two self-report measures have been presented in the literature that focus solely on the measurement of social communication abilities for persons with brain injury: The Social Communication Skills Questionnaire (SCSQ) [17] and the La Trobe Communication Questionnaire (LCQ) [11]. The SCSQ was largely based on the work of Prutting and Kirchner [18] and from input from clients participating in group discussions. While items on the measure have good face validity and the SCSQ was used as a primary outcome measure for a recent clinical trial of a social communication group intervention [19], there has been no evaluation of the psychometric properties of this instrument reported in the literature. In fact, the authors suggest that summary scores to establish 'social competence' should not be utilized; rather individual item ratings should serve as foci for intervention [17]. In addition, no alternative forms of the SCSQ for 'other' report have been developed.

The LCQ was developed specifically to measure perceived communicative abilities for adults with TBI [11]. Items were based on Damico's analysis of discourse categories [20], a commonly used method of evaluating conversation developed from the principles of cooperative conversational exchange as outlined by Grice [21]. Additional items were included on the LCQ to assess cognitive constructs typically affected by TBI that impact communication. While this measure addresses similar content to that of the SCSQ, the LCQ has undergone more extensive psychometric development. In addition, both self-report and other-report (i.e. family member or significant other-report) forms have been developed. Therefore, the current study focuses on further evaluation of the LCQ.

Factor analyses of LCQ

For the initial development of the measure, Douglas et al. [11] administered the 30-item questionnaire to 147 non-injured adults (aged 16–40 years) and 109 close others. Construct validity was explored for the self-report data for these non-injured individuals using principal component factor analysis [11]. An orthogonal varimax rotation and inspection of the scree plot revealed six factors that accounted for 48.9% of the variance. Assignment of items to individual factors was accomplished by only including items with a factor loading of 0.40 or greater and retaining items with multiple loadings if the primary loading was at least 0.10 greater than its loading on any other factor. Therefore, the six-factor solution included 25 items. Interpretive labels were suggested, including conversational tone, effectiveness, flow, engagement, partner sensitivity and focus. Although the authors assigned labels to the factors, items that loaded together on factors did not appear to be closely associated with one another conceptually and, consequently, would appear to have limited utility as clinical measure sub-scales. Published studies of the LCQ using self-report data from persons with TBI did not examine the stability or utility of these factors [22, 23].

More recently, these authors have completed a second factor analysis of the LCQ using a combined sample of 88 respondents with brain injury and 71 close others [24]. Although the authors reported producing a 7-factor solution, there were several methodological problems with this study. In addition to the small sample size, it is noted that two of the obtained 'factors' contained only a single item, while one contained only two items. Interpretation of factors defined by only one or two variables is considered hazardous, even under the most exploratory factor analysis [25]. Therefore, it is likely that a more interpretable solution would have included fewer than seven factors. Although the authors reported that each of the seven factors exceeded an eigenvalue of 1.0, no discussion was provided regarding interpretation of the scree plot to help determine the number of factors to retain from the analysis.

Another problematic issue with this second factor analysis was that the sample included respondents with brain injury and the reports of close others about these same individuals with brain injury. In other words, there were several 'double' observations of a single subject for participants included in the factor analysis. This mixed population presents potential difficulties with generalizability

of the resulting factor structure. Given these methodological concerns, it appears that further exploration of the factor structure of the LCQ, using responses from a larger sample of individuals with TBI, would be a useful step in the development of this instrument.

Comparison of self- vs other-report on LCQ

In addition to exploring the construct validity of the LCQ, the developers of the instrument were interested in whether significant differences would exist regarding the report of communication behaviours between persons with brain injury and a close other. In an early study of the LCQ administered to 16 persons with severe TBI, all of whom were within the first year post-injury, patients were found to perceive significantly fewer communication problems than did their relatives or therapists [26]. In contrast, for a separate group of 24 persons with TBI completing the LCQ at 2 years post-injury or greater, self-ratings of communication skills did not differ from relatives' ratings with regard to either overall frequency of problem behaviours or perceptions of change post-injury [27]. More recent studies have shown similar results, in that no significant differences are found in the rating of communication skills between persons with injury who are greater than 1 year post-injury and their close others [22, 28]. It appears that time post-injury may be an important factor in the concordance of reports of communication abilities between self- and other-reports after TBI.

The purpose of the current study was to further evaluate the utility and construct validity of the LCQ as a measure of communication ability in the TBI population. The aims of this study are:

(1) To further evaluate the construct validity of the instrument by conducting factor analysis of the self-report data from a larger sample of respondents with TBI.
(2) To utilize resultant factors in the development of instrument sub-scales to enhance the clinical utility of the measure.
(3) To explore whether factor sub-scale scores are associated with education, time post-injury or injury severity.
(4) To investigate the extent to which self-ratings by adults with TBI, all of whom were at least 1 year post-injury, compared with ratings of communication skill made by a significant other.
(5) To investigate discriminant validity by comparing total and sub-scale self-ratings of participants with TBI with self-ratings made by an age-, education- and gender-matched non-injured control sample.

Methods

Research participants

Participants with TBI. A total of 276 participants with TBI were included in the factor analysis of the LCQ. Persons with TBI were included from one of two studies: 121 were participants who had been recruited from the local NIDRR TBI Model System sample to participate in a project designed to evaluate social communication assessment measures (TBIMS study) and 155 were participants recruited from among consecutive admissions to a trauma centre who were involved in an ongoing project that investigates factors relating to social integration outcomes for persons with TBI (SOC INT study).

Persons participating from the TBIMS social communication study were drawn from the overall sample of TBIMS participants at the local rehabilitation site in the Southern US. Criteria for inclusion in the Model Systems study have been described elsewhere [29], but include: diagnosis of TBI resulting in admission to the emergency department of a Model System hospital between 8–24 hours post-injury; aged ≥ 16 years; acute care and inpatient rehabilitation received within the Model System facilities; residence in a designated catchment area; and provision of informed consent by the person with injury or a family member. To ensure that the sample recruited for the social communication study were representative of the overall local TBIMS cohort, comparisons of demographic and injury-related variables were conducted between participants ($n = 121$) and non-participants ($n = 302$) in the current study. There were no significant differences between these groups with respect to age at injury, gender, ethnicity or injury severity. Participants in the current study differed from the non-participants from the local TBIMS sample with respect to education. The study sample had a relatively greater proportion of individuals with 12–15 years of education and a relatively smaller proportion of individuals with 16 years of education or more ($\chi^2 = 43.5$, $p < 0.001$). Although education differences were present, it appears that the sample of current participants is generally representative of the overall local TBI Model Systems cohort.

Participants in the SOC INT study consisted of 155 participants with mild, moderate or severe TBI that were recruited from consecutive admissions to a Level 1 trauma centre. Participants completed the LCQ at least 6 months after their date of injury and were living in non-institutional settings at the time of assessment. The LCQ was administered as part of a larger battery of questionnaires and was completed either at the participant's home or at the research centre.

The two samples were combined to increase the breadth of representation of persons with TBI with regard to injury severity, time post-injury and racial/ethnic background to enhance the generalizability of results. Separate consent forms were signed for participants in the social communication project (TBIMS sample) and the social integration project (SOC INT sample). For these two studies, additional inclusion criteria restricted participants to those aged 18 years or older who were primary English speakers and excluded those with severe communication deficits (e.g. global aphasia, severe receptive aphasia), inability to communicate, prior central nervous system dysfunction, severe psychiatric disorder (e.g. schizophrenia) or severe behavioural disorders (e.g. violent or aggressive behaviours necessitating institutional residence). Persons with mild communication deficits (e.g. word-finding difficulties) or mild-to-moderate behavioural problems (e.g. inappropriate comments, difficulties respecting personal space, etc.) were not excluded from participation, as these are the kinds of behaviours that are of particular interest in the examination of social communication after TBI.

Demographic and injury-related characteristics for participants with TBI are presented in Table I. Data for participants drawn from the TBIMS sample are presented separately from that of participants from the SOC INT study, with comparisons of the two study sub-groups provided. As anticipated, given study inclusion criteria, the SOC INT study sample was less severely injured and at an earlier point in the recovery process compared to the TBIMS sample. In addition, the SOC INT study sample differed significantly with respect to educational level, ethnicity, marital status and income level. Differences in education, ethnicity and income levels were not unexpected, since participants in the SOC INT study were recruited from the county hospital setting which tends to include greater ethnic diversity and lower socioeconomic status. No significant differences were noted with regard to age or gender.

Family/friend participants. Family members or close friends were recruited for a sub-set of participants with TBI from the TBIMS sample ($n = 88$). While an attempt was made to recruit a close other informant for all participants in the TBIMS sample, not all participants with TBI had a close other available to participate in the study. Participants with TBI for which a close other respondent was obtained did not differ significantly from those for whom no close other was available ($n = 33$) with regard to age, gender or injury severity.

Family/friend participants were predominantly women (75%), Caucasian (75%) and either married or in long-term relationships (71%). Mean age was 47.27 (SD = 14.07) and mean years of education was 13.51 (SD = 2.71). About half of the family/friend participants had household income levels of $50K or less and half had incomes greater than $50K. The majority of respondents resided with

Table I. Comparison of demographic and injury-related characteristics for participants with TBI in the TBIMS and SOC INT samples.

	Total sample ($n = 276$)	TBIMS sample ($n = 121$)	SOC INT sample ($n = 155$)	p-value
Gender (freq, %)				
Female	77 (27.9%)	38 (31.4%)	39 (25.2%)	0.31
Male	199 (72.1%)	83 (68.6%)	116 (74.8%)	
Age (mean (SD), [min–max])	35.88 (13.32) [18–84]	36.79 (11.81) [18–75]	35.16 (14.38) [18–84]	0.30
Education (mean (SD), [min–max])	12.14 (3.09) [0–20]	13.32 (2.38) [6–20]	11.22 (3.27) [0–18]	0.000[a]
Race/Ethnicity (freq, %)				
Caucasian	120 (43.5%)	91 (75.2%)	29 (18.7%)	0.000[b]
African-American	74 (26.8%)	12 (9.9%)	62 (40.0%)	
Hispanic/Latino	73 (26.4%)	13 (10.7%)	60 (38.7%)	
Other	9 (3.3%)	5 (4.1%)	4 (2.6%)	
Marital status (freq, %)				
Single	155 (62.2%)	66 (54.5%)	107 (69.0%)	0.02[b]
Married/long-term partner	94 (37.8%)	55 (45.5%)	48 (31.0%)	
Household income (freq, %)				
<$20K	63 (30.3%)	23 (22.5%)	53 (40.8%)	0.02[b]
$20 001–$50K	86 (41.3%)	46 (45.1%)	48 (36.9%)	
$50 001–$100K	35 (16.8%)	17 (16.7%)	18 (13.8%)	
>$100K	24 (11.5%)	16 (15.7%)	11 (8.5%)	
Months post-injury (mean (SD), [min–max])	41.14 (47.66) [5–290]	76.54 (47.12) [13–290]	8.06 (4.24) [5–34]	0.000[a]
ER-GCS (mean (SD), [min–max])	9.06 (4.50) [3–15]	6.65 (3.76) [3–15]	11.23 (3.90) [3–15]	0.000[a]

[a]t-tests for independent samples; [b]Pearson χ-square analyses.

their loved one with brain injury (71%) and nearly all (91%) had at least several times per week contact with that individual. Spouses comprised 36.4% of the family/friend sample, while 40.9% were parents and 22.7% were either other relatives or friends of the person with brain injury.

Matched control participants.

Non-injured control participants were recruited for 80 of the participants from the TBIMS sample. Controls were matched to persons with TBI by age, gender and educational level. Matching was accomplished according to the following convention: controls must match exactly by gender, must be within +10% of the age and must be within a range of +2 years of education (for grades K-7) or +3 years of education (for grades 8 and higher) to the persons with TBI. Control participants were recruited preferentially from among friends and family members of participants with TBI; however, persons from the general community were also included when a match was not available. Potential control participants were screened to exclude for history of central nervous system dysfunction or severe psychiatric disorder. Again, an attempt to recruit matched control participants was made for all study participants; however, for 41 of the TBIMS sample participants, no control participant was identified. Women and married individuals were significantly more likely to have a matched control recruited for participation in the study.

Demographic characteristics for the sample of persons with TBI for whom matched controls were obtained and their non-injured matched controls are presented in Table II. As would be expected from the matching procedures, no significant differences were found between the groups with respect to age, gender or educational level. In addition, no significant differences were noted between the groups with respect to marital status or income level. Control participants were significantly more likely to be from ethnic minority groups ($\chi^2 = 5.78$, $p < 0.05$).

Measure

The LCQ is a 30-item questionnaire that measures perceived communication abilities. Two forms of the questionnaire are developed: the Self-Report Form and the Other-Report Form. Individual LCQ items are worded as, 'When talking to others, do you _____?' for the self-report form and 'When talking to others, does your family member/friend _____?' for the other-report form. Various communication behaviours are inserted for the blank and respondents rate their own or their family member's/friend's performance on a 4-point scale: 1 = never or rarely, 2 = sometimes, 3 = often and 4 = usually or always. Higher ratings typically reflect poorer communication skill; however, six items on the LCQ require reverse scoring. Results of the original study showed high internal consistency (Cronbach's alpha = 0.85), with good test–re-test reliability ($r = 0.76$) across an 8-week interval demonstrated for a sub-set of 24 participants [11].

Procedure

Informed consent was obtained for all participants (persons with TBI, family/friend participants and non-injured matched controls) in the TBIMS sample. As part of the social communication study protocol for the TBIMS sample, participants were

Table II. Comparison of demographic characteristics between participants with TBI and non-injured control participants.

	Persons with TBI ($n = 80$)	Controls ($n = 80$)	p-value
Gender (freq, %)			
Female	35 (43.8%)	35 (43.8%)	1.00[b]
Male	45 (56.3%)	45 (56.3%)	
Age (mean (SD), [min–max])	37.70 (12.14) [18–67]	37.14 (12.86) [18–65]	0.20[a]
Education (mean (SD), [min–max])	13.20 (2.14) [6–18]	13.09 (2.21) [7–18]	0.61[a]
Race/Ethnicity (freq, %)			
Caucasian	60 (75.0%)	46 (57.5%)	0.05[b]
African-American	7 (8.8%)	15 (18.8%)	
Hispanic/Latino	10 (12.5%)	10 (12.5%)	
Other	3 (3.8%)	9 (11.3%)	
Marital status (freq, %)			
Single	43 (53.8%)	36 (45.0%)	0.27[b]
Married/long-term partner	37 (46.3%)	44 (55.0%)	
Household income (freq, %)			
<$20K	23 (22.5%)	21 (28.8%)	0.61[b]
$20 001–$50K	46 (45.1%)	29 (39.7%)	
$50 001–$100K	17 (16.7%)	16 (21.9%)	
>$100K	16 (15.7%)	7 (9.6%)	

[a]t-tests for independent samples; [b]Pearson χ-square analyses.

given a series of measures, including the LCQ. Participants in the SOC INT study were individuals with TBI recruited from a Level 1 trauma hospital for a study to investigate factors related to social integration after brain injury. Informed consent was obtained and the LCQ was among a number of measures administered to participants after discharge from acute care or inpatient rehabilitation and at least 6 months post-injury. Both of the studies were reviewed and approved by the Institutional Review Board.

Statistical analysis

The 30-item La Trobe Communication Questionnaire (LCQ) was assessed for normality assumptions. All of the items were noted to be mildly to moderately positively skewed, which is not unexpected in a sample of participants not specifically chosen to have communication difficulties. These items were transformed to reduce skewness by taking the log of the raw scores. None of the cases had missing responses on any LCQ item. The 30 items of the original LCQ were subjected to principal components analysis (PCA) with varimax rotation [11]. The transformed and raw score items were utilized in the analysis and compared. Very similar factor structures emerged from both analyses; therefore, for ease of interpretation only the analysis of the raw scores is reported.

Factor scores of the participants were calculated for each of the identified factors by the Regression method. Multiple linear regression analyses were used to examine the extent to which independent predictor variables (years of education, emergency room Glasgow Coma Scale score (ER-GCS) and months post-injury) accounted for variance in the resultant LCQ factor scores.

Utilizing the four resultant factors, sub-scale scores were developed by summing the individual LCQ items that comprised each factor. Comparisons of the LCQ self-rating sub-scale scores with that of friends/family members were performed using paired-samples *t*-tests to assess differences with respect to the LCQ total score and the four proposed LCQ sub-scale scores. An additional comparison of the LCQ self-rating sub-scale scores with that of the non-injury matched control participants was performed. All analyses were conducted using SPSS 15.0 for Windows.

Results

Factor analysis

Prior to performing PCA, the suitability of the data for factor analysis was assessed. Inspection of the correlation matrix revealed that each item of the LCQ correlated fairly well with all others by the presence of 166 correlation coefficients of at least 0.30. The Kaiser-Meyer-Olkin value was 0.90, exceeding the recommended value of 0.60 [25]. The Bartlett's Test of Sphericity reached statistical significance ($p < 0.001$), supporting the factorability of the correlation matrix. These results were deemed appropriate for proceeding with PCA.

The initial principal components analysis revealed the presence of six components with eigenvalues exceeding 1, explaining 53.60% of the total variance. After inspecting the scree plot, several PCA runs specifying four-to-six factor extractions were performed to determine the optimal number of extracted components, while retaining a significant amount of variance explained. The four-factor solution was selected as having the best and most parsimonious fit. Five- and six-factor solutions produced poorly defined loading matrices, each producing at least one factor which was defined by only one item [25]. Varimax rotation was performed in order to abet the interpretation of the extraction of four factors. The rotated solution revealed the presence of simple structure [25], indicating that all four factors showed a number of strong loadings and all variables loaded substantially on only one component.

Orthogonal and oblique rotations were performed. Modest correlations were found between factors; however, the results of the oblique promax rotation produced the same factor structure as the orthogonal varimax rotation. Since the goals of analysis were to use factor scores in other analyses and compare the factor structure in groups, an orthogonal rotation was chosen for clarity of factor interpretation. The four factors accounted for 46.45% of the total variance explained (Factor 1 = 17.16%; Factor 2 = 10.94%; Factor 3 = 9.18%; Factor 4 = 9.17%).

Factor loadings were deemed significant if the variable loaded greater than 0.40 on a given factor. All but three of the items from the LCQ loaded at least 0.40 on a given factor. Two items had double loadings greater than 0.40 on factors 1 and 4, with loading differences of 0.084 and 0.179, respectively. These items were included on the factor for which the highest loading was found.

Examination of the item content for the four factors indicated that the first factor was comprised of items related to difficulties with starting and maintaining conversations (Initiation/Conversational Flow factor). Items on the second factor appeared to represent impulsive or disinhibited conversational behaviours, such as saying rude or embarrassing things (Disinhibition/Impulsivity factor). The third factor consisted of items related to the effectiveness of conversation, such as being accurate and logical in

expression and having the ability to change speech style easily (Conversational Effectiveness). The fourth factor consisted of items related to sensitivity to a conversational partner's needs, such as repeating information, talking about things for too long and switching topics too quickly (Partner Sensitivity factor).

A second exploratory analysis was conducted on a reduced item set in order to increase interpretability by obtaining a simpler factor structure. The three items mentioned previously that loaded less than 0.40 on any given factor were eliminated. Therefore, the remaining 27 LCQ questions were used for further exploratory analysis. The principal component analysis with varimax rotation of the 27-item set replicated the 4-factor structure of the original 30-item set of the LCQ, while explaining 48.25% of the total variance (Factor 1 = 17.74%; Factor 2 = 11.08%; Factor 3 = 10.08%; Factor 4 = 9.36%). Again, the same two items had double loadings greater than 0.40 on factors 1 and 4 and the items were included on the factor for which the highest loading was found. Table III shows the factor loadings, communality estimates and total explained variance for the reduced item set. The items remained in their respective factor groups.

Internal consistency

Cronbach's α was calculated for each factor obtained for the reduced item analysis. All four of the factors showed acceptable to good internal consistency (see Table IV).

Sub-scale scores

To facilitate potential clinical utility of the instrument, sub-scale scores were calculated by summing the raw scores for items loading on each of the four factors using the factor structure obtained from the 27-item analysis (see Table V). Ten items were

Table III. Varimax rotated principal component loadings and communality estimates for 27-item La Trobe Communication Questionnaire.

Item #	Questionnaire item	Factor I	Factor II	Factor III	Factor IV	h^2**
	Initiation/Conversational Flow					
5	Need a long time to think before answering the other person?	**0.75***				0.59
18	Have difficulty getting the conversation started?	**0.72**				0.59
14	Need the other person to repeat what they have said before being able to answer?	**0.63**				0.45
6	Find it hard to look at the other speaker?	**0.63**				0.44
26	Have difficulty thinking of things to say to keep the conversation going?	**0.63**				0.50
7	Have difficulty thinking of the particular word you want?	**0.60**				0.51
8	Speak too slowly?	**0.56**				0.40
16	Make a few false starts before getting your message across?	**0.55**				0.50
13	Find it difficult to follow group conversations?	**0.51**				0.42
2	Use a lot of vague or empty words such as 'you know what I mean' instead of the right word?	**0.51**				0.46
	Disinhibition/Impulsivity					
22	Speak too quickly?		**0.68**			0.52
9	Say or do things others might consider rude or embarrassing?		**0.62**			0.46
24	Allow people to assume wrong impressions from your conversations?		**0.60**			0.44
27	Answer without taking time to think about what the other person has said?		**0.60**			0.46
17	Have trouble using your tone of voice to get the message across?		**0.49**			0.44
12	Get 'sidetracked' by irrelevant parts of the conversation?		**0.44**			0.42
29	Lose track of conversations in noisy places?		**0.44**			0.37
	Conversational Effectiveness					
23R	Put ideas together in a logical way?			**0.76**		0.61
15R	Give people information that is correct?			**0.69**		0.49
21R	Find it easy to change your speech style (e.g. tone of voice, choice of words) according to the situation you are in?			**0.64**		0.48
19R	Keep track to the main details of conversations?			**0.61**		0.45
28R	Give information that is completely accurate?			**0.60**		0.40
11R	Know when to talk and when to listen?			**0.56**		0.43
	Partner Sensitivity					
3	Go over and over the same ground in conversation?				**0.71**	0.56
25	Carry on talking about things for too long in your conversations?				**0.63**	0.51
10	Hesitate, pause or repeat yourself?				**0.62**	0.61
4	Switch to a different topic of conversation too quickly?				**0.55**	0.54
Percentage Variance (48.25%)		17.74	11.08	10.08	9.36	

*Boldface indicates significant primary loadings ($\geq$ 0.40) of items on each factor; ** h^2 = communalities.

Table IV. Psychometric properties of La Trobe Communication factor composite scales.

Factor scales ($n = 276$)	# Items	*M*	SD	$\alpha^{\star}$
Initiation/Conversational Flow	10	18.0	6.0	0.87
Disinhibition/Impulsivity	7	13.0	4.2	0.77
Conversational Effectiveness	6	12.5	4.2	0.74
Partner Sensitivity	4	7.8	2.9	0.75

*Cronbach's alpha.

Table V. Scoring recommendations for 27-item La Trobe Communication Questionnaire using summed raw scores for items.

Initiation/Conversational Flow scale	Disinhibition/Impulsivity scale	Conversational effectiveness scale	Partner sensitivity scale
2 + 5 + 6 + 7 + 8 + 13 + 14 + 16 + 18 + 26	9 + 12 + 17 + 22 + 24 + 27 + 29	11R* + 15R + 19R + 21R + 23R + 28R	3 + 4 + 10 + 25

*'R' denotes reverse scored items (e.g. 1 = 4, 2 = 3, 3 = 2, 4 = 1).

summed to obtain the Initiation/Conversational Flow sub-scale score, seven items yielded the Disinhibition/Impulsivity sub-scale total, six items yielded the Conversational Effectiveness sub-scale total and four items yielded the Partner Sensitivity sub-scale total. To explore whether such summed raw scores yielded reasonable approximations of the factor scores, Pearson correlations between the summed raw scores and factors were calculated. The relationship between the summed scale scores and the estimated factors were satisfactory, showing high correlations. Correlations between the summed raw item sub-scale scores and factor scores for each of the factors were as follows: Initiation/Conversational flow score with Factor 1 ($r = 0.85$), Disinhibition/Impulsivity score with Factor 2 ($r = 0.88$), Conversational Effectiveness with Factor 3 ($r = 0.98$) and Partner Sensitivity with Factor 4 ($r = 0.86$).

Relationship with demographic and injury-related variables

Separate regression models using a forced entry method were tested as exploratory analyses to investigate potential relationships between demographic and injury-related variables with each of the four factors. Predictors used in each model included years of education, months post-injury and emergency room Glasgow Coma Scale score (ER-GCS). Demographic and injury-related variables did not make a statistically significant unique contribution to the overall models for the Initiation/Conversational Flow, Disinhibition/Impulsivity or Conversational Effectiveness factors.

Demographic and injury-related predictor variables contributed statistically significantly ($F(3,255) = 2.59$, $p = 0.05$) to Partner Sensitivity, although accounting for only 3.0% of the variance. Of the three predictor variables, only ER-GCS ($\beta = -0.16$, $p = 0.02$) made a statistically significant unique contribution, accounting for 2.2% of the variance. As injury severity increased (decreased ER GCS scores), greater difficulty was perceived for partner sensitivity in conversation.

Comparison of LCQ self-ratings and ratings by frziends/family members

For participants from the TBIMS sample, a close friend or family member of the participant with TBI was asked to complete the LCQ to rate the participant's communicative abilities. Paired-samples *t*-tests were conducted to analyse and compare ratings of the 88 participants with TBI to their friend's/family member's ratings. Mean replacement within sub-scale mean or overall LCQ item mean (when item missing did not belong to an individual sub-scale) was performed on three friend/family member cases with a missing value prior to conducting the paired-samples *t*-test. Mean comparisons were made using the LCQ total score and the four LCQ sub-scales. Results are shown in Table VI. No significant differences were noted.

Comparison of LCQ self-ratings between persons with TBI and non-injury matched control participants

Paired-samples *t*-tests were conducted to compare the participants with TBI from the TBIMS sample to their matched controls with regard to LCQ total score and the four LCQ sub-scales. Mean replacement within sub-scale mean or overall LCQ item mean (when item missing did not belong to an individual sub-scale) was performed on two control cases with a missing value prior to conducting the paired-samples *t*-test. Results are

Table VI. LCQ score comparisons for TBI vs family matches.

	TBI ($n = 88$)	Family ($n = 88$)	Std. Error of Mean	*t*-Statistic	*p*-value
LCQ total score	53.52	54.71	1.53	−0.77	0.44
Initiation/Conversational Flow scale	18.15	17.87	0.73	0.38	0.70
Disinhibition/Impulsivity scale	13.19	14.17	0.57	−1.71	0.09
Conversational Effectiveness scale	12.97	14.02	0.62	−1.69	0.10
Partner sensitivity scale	8.17	8.24	0.36	−0.19	0.85

Table VII. LCQ score comparisons for TBI participants vs matched control participants.

	TBI ($n = 80$)	Control ($n = 80$)	Std. Error of Mean	*t*-Statistic	*p*-value
LCQ total score	51.89	48.51	1.51	2.24	0.03*
Initiation/Conversational Flow scale	17.46	15.88	0.77	2.35	0.04*
Disinhibition/Impulsivity scale	12.61	12.22	0.47	0.84	0.40
Conversational Effectiveness scale	13.10	11.83	0.70	1.82	0.07
Partner Sensitivity scale	7.46	7.31	0.36	0.42	0.68

*Means are statistically different at the $p < 0.05$ level.

shown in Table VII. Individuals with TBI reported significantly greater difficulties with communication on the Initiation/Conversational Flow sub-scale and the overall total LCQ score than did matched controls. The eta-squared statistic was 0.059 and 0.051, respectively, indicating a moderate effect size. There was a trend towards statistically significant differences between persons with TBI and their matched controls on the Conversational Effectiveness sub-scale, with individuals with TBI reporting greater difficulties with communication.

Discussion

The 4-factor structure that emerged from factor analysis of the 27-item LCQ responses for this sample of individuals with TBI accounted for 48.25% of the total variance. Factor loadings were relatively high and all items loaded significantly on factors. The four factors were labelled in respective order: Initiation/Conversational Flow, Disinhibition/Impulsivity, Conversational Effectiveness and Partner Sensitivity. The resulting factors made sense conceptually, as individual items that loaded together appeared to contain associated content. These overall constructs also make sense from a clinical perspective and would appear to yield potentially meaningful information that could be used by clinicians to target specific areas of communication functioning for intervention. In addition, internal consistency was explored for the four factor scores and was found to range from acceptable to good ($\alpha = 0.74$–0.87). Recommendations for a scoring mechanism to generate sub-scale scores from the raw score data were presented and found to be highly correlated to the corresponding factor scores.

While the obtained factor structure differed significantly from that obtained by Douglas et al. [24], such differences were not unexpected given some of the methodological issues that were present in that original study, including small sample size and poorly defined loading matrices. The current study retained factors based on both the presence of eigenvalues exceeding 1.0, examination of the scree plot and comparison of four-, five- and six-factor solutions. While Douglas et al. [24] retained seven factors in their study, three of the seven factors contained only one or two items, which is considered hazardous when using factor analysis [25]. Given this, it would appear that a 4-factor solution may have better explained the data from this investigation as well.

The current study includes data from a broad representation of persons with TBI with respect to initial injury severity, time post-injury and racial/ethnic background. Therefore, the factor structure obtained from this sample is likely to be a relatively stable one and would likely be robust when utilized with other TBI samples.

To date, three separate studies have conducted exploratory factor analysis with the LCQ, yielding three different solutions. Principle components analysis and factor analysis contain an inherent aspect of ambiguity. There is no criterion variable against which a solution may be tested and an infinite number of solutions may be identical from a mathematical perspective [25]. An important test of such analyses is the interpretability of the results which depends on the degree to which observed

variables correlated highly with a given factor and do not correlate with other factors. The adequacy of factor extraction must involve a balance between adequacy of fit between the observed and reproduced correlation matrices and parsimony [25]. The current study included a larger sample of the target population of individuals with TBI with broad representation with respect to injury severity, time post-injury and race/ethnicity, which yielded a factor structure that had good interpretability.

The relationship between selected demographic and injury-related variables and LCQ scores was explored. No statistically significant relationships were noted with regard to education level or time post-injury. A statistically significant relationship was found between injury severity, as measure by ER-GCS and the Partner Sensitivity score, but not between injury severity and the other sub-scale or total scores. While this relationship was statistically significant, injury severity accounted for a very small amount of the variance in Partner Sensitivity, suggesting that the clinical significance of this finding is limited. Although limited relationships were noted between injury severity and self-reported communication abilities in this exploratory analysis, it is noted that the only measure of injury severity used was the ER-GCS score. Use of this score to categorize injury severity is not without problems, as the score may be artificially lowered due to various factors (e.g. administration of sedatives/paralytics in the field, intubation, presence of alcohol or other drugs, etc.) [30], leading to an over-estimation of injury severity. In other cases, however, ER-GCS scores may not capture potential complications or neurological deterioration resulting from expanding mass lesions [30], leading to an under-estimation of injury severity. Thus, relationships between injury severity and outcome variables may be weakened due to the introduction of this measurement error. In addition, it is possible that the influence of injury severity on communication functioning may have less importance as time post-injury increases. Thus, given that a large proportion of the current sample were more than 1 year after injury, the effect of injury severity may have been limited.

An important finding of the current study was that the perceptions of persons with TBI regarding their communication abilities did not differ substantially from the report of their family member/friends for any of the four factors investigated, although trends were noted for persons with TBI to rate themselves as having less difficulty on the Disinhibition/Impulsivity sub-scale ($p = 0.09$) and on the Conversational Effectiveness sub-scale ($p = 0.10$) as compared to family members/friends. The findings are consistent with previous research which has found no significant differences in the rating of communication skills between persons with injury who are greater than 1 year post-injury and their close others [22, 27, 28]. This supports the idea that time post-injury may be an important factor in the concordance of reports of communication abilities between self- and other-reports after TBI.

Comparisons of LCQ self-ratings between persons with TBI and non-injured matched control participants yielded several noteworthy findings. On the Initiation/Conversational Flow sub-scale as well as the overall LCQ total score, persons with TBI reported greater communication difficulties relative to non-injured matched control participants. In addition, individuals with TBI showed a trend towards reporting greater difficulty with Conversational Effectiveness than did matched controls. These results are consistent with findings in the literature showing that decreased communication abilities are common among persons with moderate-to-severe TBI [1–3]. Additionally, the obtained results provide empirical evidence suggesting that the general index identified in this study (LCQ total score) shows good discriminatability between persons with TBI and non-injured controls. This is an important finding, as prior research has focused on comparisons between self-ratings of persons with TBI and ratings of close others and comparisons using non-injured matched controls have not been conducted to the authors' knowledge.

Since participants with TBI were not specifically selected for presence of social communication problems, the differences in perceived communication abilities may not have been as notable when compared to self-rating of matched control participants. That is, a percentage of participants with TBI in this current study would be considered to have no impairments in social communication functioning, which may have diminished the differences seen between participants with TBI and controls. Another issue that may have limited the potential differences seen between persons with TBI and their control participants was the care that was taken regarding matching characteristics. Controls for this study were matched based on age, gender and education and were also selected from among individuals in the friend or family circles of participants with TBI in this study. Thus, the control sample may be more comparable to the participants with TBI than may be seen in many studies where controls are obtained from a university student population or a hospital volunteer population. This more representative control sample may also be useful in illustrating that there is a range of communication abilities among persons in general, whether a brain injury has been sustained or not. Such broad overlap in functioning between populations contributes to the great challenges that are

present in designing effective outcome measures for social communication.

Conclusion

There is a great need for measures that address social communication abilities following TBI. The LCQ appears to hold promise as a tool to measure such abilities. Results of the current study provide additional support for the use of this measure with persons with TBI. Underlying constructs from zthe measure revealed through factor analysis, including Initiation/Conversational Flow, Disinhibition/Impulsivity, Conversational Effectiveness and Partner Sensitivity, appear to have good face validity and may provide information that clinicians can utilize to target interventions. The current study found acceptable-to-good internal consistency for the four factors and a method for producing sub-scale scores from raw data showed high correlations with factor scores. Thus, the use of the La Trobe Communication Questionnaire and the proposed scoring algorithms is recommended in future studies of persons with TBI. The instrument appears to hold promise, both with regard to research and clinical utility. Further development of this instrument and confirmation of this factor structure would be recommended in future studies.

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