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Effects of social cognitive demand on Theory of Mind in conversations of adults with traumatic brain injury

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Abstract

Background—A requisite skill for successful conversation is the ability to adjust one's language according to contextual factors.

Aims—This study examined one aspect of language use in context – the use of mental state terms, i.e. words that communicate thoughts, beliefs, or feelings– in conversations between adult males with and without traumatic brain injury (TBI) and familiar partners.

Methods and Procedures—Participants were 5 males in the chronic stage of recovery following severe TBI and 5 male peers matched for age, conversing with friends. Conversational context was manipulated using conversation starters that were designed to induce differing levels of self-disclosure or intimacy, with the expectation that mental state term use would increase when participants talked about more intimate topics.

Outcomes and Results—Participants in both groups used more mental state terms in more intimate conversations, however adults with TBI did not increase their mental state term use to the same extent as matched peers. Adults with TBI also used a significantly different pattern of mental state term types across intimacy levels as compared to peers.

Conclusions and Implications—These quantitative and qualitative differences may contribute to social conversation problems of adults with TBI.

Keywords

communication; brain injury; social cognition; language; mentalizing; discourse

Background

The chronic social problems of adults with traumatic brain injury (TBI) have been well documented in the literature (Finset, Dyrnes et al. 1995; Dahlberg, Hawley et al. 2006). The general assumption has been that these problems reflect some combination of impairments in executive functions (EFs) and working memory (Godfrey and Shum 2000; Wood and Rutterford 2006; Struchen, Pappadis et al. 2008). There is growing recognition, however, that individuals with TBI may have specific impairments in the ability to process social information, i.e., in social cognition (Turkstra, McDonald et al. 2001; Martin and McDonald 2003; Bibby and McDonald 2005). Social cognition has been defined as “the processes that subserve behavior in response to conspecifics” and “those higher cognitive processes subserving the extremely diverse and flexible social behaviors that are seen in primates”

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(Adolphs 1999: 469). Social cognitive processes include Theory of Mind (ToM), the conceptual system used to reason about beliefs, emotions, and mental states (Premack and Woodruff 1978). ToM allows individuals not only to perceive social cues but also to predict the behavior of others (Premack and Woodruff, 1978). It is thought to be a requisite skill for competent communication (Frith and Frith 1999; Miller 2006), as it allows individuals to “take the perspective” of their conversational partners.

Studies have identified a complex network of brain regions involved in social cognition, including cortical and subcortical areas (Adolphs 1999; Adolphs 2009), and also white matter tracts that support the integration of information from spatially distinct cortical regions (Charlton, Barrick et al. 2009). These same regions and pathways are commonly damaged in individuals with TBI (Milders 2006; Kennedy, Wozniak et al. 2009). Consistent with this, several studies have shown impairments in ToM and emotion recognition in adults with TBI (Martin-Rodriguez and Leon-Carrion 2010). Havet-Thomassin and colleagues (2006) and Turkstra (2008) found that adults with severe TBI showed significantly poorer performance than controls on the ‘Reading the Mind in the Eyes Task’ (Baron-Cohen, Wheelwright et al. 2001), which requires the examinee to infer mental states from photographed images of the eyes of actors. Havet-Thomassin et al. also found that individuals with TBI had lower scores than controls on a task requiring individuals to predict the conclusion of a comic-strip story based on a character’s intentions. Similarly, Milders and colleagues (2006) reported that individuals with TBI performed more poorly than age- and education-matched peers on faux-pas and false-belief tasks, both shortly after injury as well as at one year post-injury. In an effort to study ToM in a more ecologically valid social task, researchers have also used video-based stimuli that depict dynamic social scenarios (Turkstra, McDonald et al. 2001; McDonald and Flanagan 2004; McDonald, Bornhofen et al. 2006; Turkstra 2008). Studies using these tasks have shown deficits in individuals with TBI, particularly on second-order false beliefs, or beliefs about other people’s beliefs (McDonald and Flanagan 2004; Turkstra, Dixon et al. 2004; Turkstra 2008).

While there is growing evidence that individuals with TBI show ToM impairments on laboratory-based tasks, it is less well understood how these impairments are manifested in everyday life. One type of everyday social activity in which ToM is likely to play a role is conversation, a context in which individuals with TBI report chronic problems (Dahlberg, Hawley et al. 2006), and one that is thought to be particularly sensitive to communication impairments (Coelho, Ylvisaker et al. 2005). As conversation requires ongoing inferences about the intentions and emotions of one’s partner, it is an ideal mode of communication in which to evaluate ToM. Stronach and Turkstra (2008) found that adolescents with TBI who had low scores on ToM tests also used fewer thought- or feeling-related words (mental-state terms) in conversation than did either adolescents with TBI who had high ToM test scores or age-, race-, and gender-matched peers. These results suggested that analysis of mental-state terms might provide a window into ToM use beyond laboratory tasks. The study was limited, however, because many of the conversation partners were researchers as opposed to frequent conversation partners. The use of researcher partners is common practice in studies of communication after TBI (Bond and Godfrey 1997; Snow, Douglas et al. 1997; Ewing-Cobbs, Brookshire et al. 1998; Galski, Tompkins et al. 1998; Snow, Douglas et al. 1998; Snow, Douglas et al. 1999; Van Leer and Turkstra 1999; Coelho 2002; Chapman, Sparks et al. 2004; Coelho, Grela et al. 2005) but it has significant limitations in regard to predictive and ecological validity. Individuals with and without TBI change their communication style depending on partner characteristics and the nature of the task (Togher, Hand et al. 1996; Togher, Hand et al. 1997; Van Leer and Turkstra 1999). Therefore, results of studies in which clinicians or researchers serve as communication partners may not be predictive of everyday performance.

Aims

The present study was designed to build on earlier research by searching for evidence of ToM in conversations with familiar partners. The first aim was to determine if adults with TBI used fewer MSTs in conversations when compared to healthy controls. This was, in effect, a replication of the earlier study by Stronach & Turkstra (2008), with everyday partners rather than researchers and adults rather than adolescents.

The second aim was to compare adults with TBI to controls in the extent to which they adapted MST use to conversation topics with differing social cognitive demands. Individuals with TBI are often described as “egocentric” or “failing to provide social reinforcement” (Bond and Godfrey 1997) and we wondered if this might reflect failure to adjust language to the social cognitive context. To manipulate the ToM demands of participants’ conversations, the Relationship Closeness Induction Task (RCIT; Sedikides, Campbell et al. 1999) was used as an elicitation technique. The RCIT was originally designed to develop relationship closeness between unfamiliar participants by requiring dyads to engage in three conversations, each guided by a progressively more intimate question list designed to induce increasing levels of personal disclosure (Sedikides, Campbell et al. 1999). The RCIT has been used to examine the effect of interpersonal closeness on social behavior (Sedikides, Campbell et al. 1998; Heatherton and Vohs 2000; Vohs. and Heatherton 2004) and previous RCIT participants have reported that they viewed the RCIT questions as a useful way to gain familiarity with a stranger and frequently participated in conversations similar to those elicited by the RCIT (Sedikides, Campbell et al. 1999). To communicate appropriately on the RCIT, each participant must perceive social cues related to the intimacy level of the conversation and modify language use accordingly.

In typical speakers, the use of MSTs would be expected to increase as conversational intimacy level increases, as interlocutors reflect more on their own thoughts and feelings and those of others. By contrast, individuals with TBI might be expected to use a similar number of MSTs across intimacy levels. This prediction is based on two findings from the TBI literature: 1) evidence of impairments in ToM, as discussed earlier, so that participants with TBI might not perceive social cues related to intimacy and self-disclosure; and 2) evidence of impairments in executive functions hypothesized in previous studies to play a role in social behavior after TBI, including self-regulation and metacognition (Busch, McBride et al. 2005; Ownsworth and Fleming 2005; Stronach and Turkstra 2008; Struchen, Pappadis et al. 2008). It was hypothesized that even if participants detected social cues they might not recognize the need or be able to change their behavior in response to changes in context cues.

The third aim was to look more closely at types of MSTs used. MSTs express cognitions (e.g., think, know, remember), emotions (e.g., happy, sad, angry), or desires (e.g., want, hope), and the cognitive processes required to reflect on these different constructs may vary in the social cognition demand. For example, children begin to use emotion-related MSTs earlier in development than MSTs related to cognitive functions or beliefs (Bretherton and Beeghly 1982), suggesting that the former reflect more basic mentalizing. Adrian and colleagues (2005) found that, cognitive and emotional term use by mothers was associated with child ToM test performance, while mothers’ use of desire terms was not (Adrian, Clemente et al. 2005), again suggesting that some types of MSTs may be more indicative of ToM than others. Based on these findings, individuals with TBI were expected to use fewer cognitive- or emotion-state terms than typical peers, but the same number of MSTs related to desire.

Methods and Procedures

Participants

Participants were five adult males with TBI (ages 35–53 years) and five males without TBI (ages 25–62 years), and an adult chosen by each participant as his frequent communication partner. Two additional participants, one with TBI and one without TBI, were excluded for failure to complete the study protocol, and one other additional participant without TBI was excluded because his conversation partner was not a native speaker of English.

All participants were native speakers of Standard American English, by self-report, and were recruited from community sources. Participants with TBI were required to have no pre-morbid history of language or learning disability, special education services, gifted status, or psychiatric or neurologic disorder affecting cognitive functioning, all by self-report. Conversation partners met the same inclusion criteria, and none had sustained a TBI. Four of five participants with TBI chose caregivers as partners, but in all cases the participant considered that person to be a friend and his most frequent conversation partner. A matched-pair Wilcoxon revealed no significant difference in age between the two groups ($Z=0.14$, $p = 0.89$). Participants and their conversation partners in both groups came from a variety of socioeconomic backgrounds, from laborer to professional. Qualitative descriptions of participant educational level were collected per participant report. While these data did not allow for quantitative comparison of education across groups, inspection of this data revealed that the education distribution was quite similar in the two groups (see Table 1). Participants with TBI had sustained their injuries at least 6 months before completing the study protocol and in adulthood, so that ToM performance would reflect change from pre-morbid abilities rather than failure to develop ToM (Slaughter 2006). Participant details are provided in Tables 1 and 2.

Conversation Task

Each pair of participants completed the RCIT (Sedikides, Campbell et al. 1998) shown in Appendix A. The RCIT is comprised of three question lists: superficial disclosure (Level 1), intermediate disclosure (Level 2), and intimate disclosure (Level 3). As the RCIT questions were written for use with university students, the wording of some questions was changed to be appropriate for use with individuals with TBI and their partners, as is allowed by the original authors (Sedikides, Campbell et al. 1999). As in previous research using the RCIT (Vohs. and Heatherton 2004), participants were given 2 minutes to discuss Level 1 questions, 6 minutes for Level 2 questions, and 10 minutes for Level 3. The allowed discussion time was increased as the question lists became more intimate, to allow adequate response time for more complex questions (e.g. answering “Describe the last time you were lonely” was expected to require a longer response time than, “What is your hometown?”).

Procedure

All participants and their conversation partners gave informed consent or assent with guardian consent. Each dyad (participant + partner) was presented with the Level 1 questions and asked to chat for a few minutes using the questions as “conversation starters”. Participants were told that they were not required to speak exclusively about the questions provided. The researcher then started the video camera and left the room. When the time for that list was up, the researcher re-entered the room, removed the question list, and then repeated the same process for the remaining two sets of questions. Question lists were always presented in order of increasing intimacy, as suggested by the authors (Sedikides, et al., 1998), so that conversations developed in a way that was similar to that of natural relationships and conversations.

The Kaufman Brief Intelligence Test, Second Edition (K-BIT2; Kaufman and Kaufman 2004) was also administered to all participants as a general measure of intelligence. The K-BIT was administered according to the provided standardized procedure and standard IQ composite scores were calculated. One individual with TBI was unable to complete this test due to poor vision.

Participants and partners were paid \$15 each for their participation. All procedures were approved by the Social and Behavioral Sciences Institutional Review Board at the University of Wisconsin-Madison.

Data Analysis

Each conversation was transcribed orthographically and utterances were segmented into terminable units (T-units) by the first author and one undergraduate research assistant. A T-unit was defined as an independent clause plus any subordinate clauses associated with it (Van Leer and Turkstra 1999; Coelho, Grela et al. 2005). Analysis focused on conversations prompted by the Level 1 and Level 3 questions, to maximize the contrast in intimacy level between question sets. A second rater analyzed 10% of the transcripts and inter-rater agreement for transcription was 90%.

Transcribed conversations were analyzed using the Systematic Analysis of Language Transcripts (SALT; Miller and Chapman 1994–2004). Meaningful disfluencies, such as “um” or “ah,” non-word utterances (e.g., “mhm”), and overlapping utterances were included in the transcription because they were considered to contribute to understanding of speaker content or mental state. Mazes were defined as one or more words that disrupted the flow of speech and did not contribute to speaker content, including false starts, repetitions, and fillers. As the study focused on content, mazes were excluded from analysis. Standard language measures calculated by SALT were computed for descriptive purposes.

Data were analyzed using the list of MSTs used by Stronach and Turkstra (2008), which was expanded to include MSTs that were used by the present participants. The final list (see Appendix B) included many words not used by participants in the prior study, likely due to differences in both task and participant characteristics (e.g., adolescents vs. adults).

MSTs were included if they were used to describe either the participant’s own or someone else’s mental state. As a validity check, two examiners (the first author and an undergraduate research assistant) reviewed each term identified to determine if it was being used to describe a mental or physical state, vs. as a filler. For example, the word *like* is an MST in the context of “I like to read novels”, and a filler in the context of “We, like, went out that night.” Point-to-point agreement between the first author and the research assistant, who was blind to group status, was 98.67%, based on ten percent of all transcripts. Each MST was classified into one of three categories: cognitive state, emotion state, or desire state (Adrian, Clemente et al. 2005). Inter-rater agreement for categorization of MSTs was 83.03%. Due to the complex nature of semantic categorization, reliability for MST categorization was relatively low compared to the level achieved for t-unit segmentation; however, all disagreements were resolved by discussion. All instances of incongruent MST categorization were for cognitive and emotional states, while agreement for desire state terms was 100%.

Three dependent measures were calculated: 1) number of MSTs at each of Level 1 and Level 3, divided by the total number of T-units to account for differences in conversation length and the number of utterances spoken by each participant; 2) change from Level 1 to Level 3 in total number of MSTs used; and 3) change from Level 1 to Level 3 in the proportion of MSTs from each of the three categories listed above. Non-parametric tests

were used for statistical analysis. Number of MSTs and change from Level 1 to 3 were compared using a Wilcoxon Matched-Pair Test. Tests were one-tailed, with the expectation that scores would be lower in the TBI group (i.e., fewer total MSTs and smaller change from Level 1 to Level 3). The change in relative proportion of MST types was evaluated using a Chi-Squared Test. The criterion alpha level was 0.05.

Outcomes and Results

Composite scores on the K-BIT for individuals with TBI ranged from 80–93 (Median = 86.5) while the composite scores for the control group ranged from 95–122 (Median = 101), (see Table 1). Because one participant with TBI was unable to complete the K-BIT due to poor vision, a group comparison could not be completed however, it is noted that the range of K-BIT scores of the participants with TBI did not overlap with that of the comparison group. K-BIT composite scores were also calculated for the partners (see Table 2), and there was no difference in partner IQ between the two groups, $Z=1.36$, $p=0.17$.

Standard language measures are shown in Table 3. There were no significant group differences in total number of utterances or words, mean length of utterance, type-token ratio, percent of utterances that were intelligible, or number of mazes per t-unit. The type-token ratio (i.e., number of different words) was significantly higher in the Level 1 condition than in the Level 3 condition for both the TBI and control groups, $Z=2.02$, $p=0.04$ for both groups, indicating that participants used a greater variety of words in the less intimate condition.

MST data are summarized in Table 3. The number of MSTs per T-unit used by the TBI group was significantly higher in Level 3 than Level 1, $Z=2.02$, $p=0.04$. The control group also significantly increased their MST use from Level 1 to Level 3, $Z=2.02$, $p=0.04$. As shown in Figure 1, there was a group X level interaction, as comparison peers increased their MST use from Level 1 to Level 3 to a significantly greater extent than did adults with TBI, $Z=2.02$, $p=0.04$. [INSERT FIGURE 1 HERE] As shown in Figure 2, adults with TBI also used a significantly different pattern of MST types in Level 1 vs. Level 3 conversations, as compared to control participants, $X^2=45$, $p<.01$. While both groups used more cognitive- or emotional-state words than words related to desire, the TBI group used more cognitive-state words than emotion-state words as conversations became more intimate, whereas typical peers showed the opposite pattern.

A potentially confounding factor was a group difference in the extent to which participants adhered to the RCIT questions (e.g., if participants in the TBI group were tangential). Thus, the data were analyzed for topics. To do so, the first author identified the general topic of each T-unit produced then categorized that topic as either related or unrelated to one of the RCIT questions for that conversation. A second rater completed the same analysis for ten percent of the transcripts, and inter-rater reliability for topic analysis was 91%. Matched-pair Wilcoxon tests showed that the two groups did not differ in total number of topics discussed in Level 1 conversations, $Z=0.54$, $p=0.59$ or Level 3 conversations, $Z=0.94$, $p=0.35$. There was no significant difference between groups in the percent of t-units related to RCIT questions for Level 1, $Z=1.09$, $p=0.28$ or Level 3, $Z=-0.94$, $p=0.35$. Conversational partners also did not differ in the percentage of t-units that related to the question lists, in either Level 1, $Z=1.09$, $p=0.28$ or Level 3, $Z=-0.67$, $p=0.50$.

Conclusions and Implications

The present study adds to a growing body of evidence of deficits in social cognition in adults with TBI, and suggests that social cognitive impairments may be apparent in everyday interactions. Previous research led to the hypotheses that adult males with TBI

would use fewer MSTs than controls overall, would not increase MST use in response to more intimate conversational topics to the same extent as controls, and would use different types of MSTs than would their peers. These hypotheses were partially supported. Participants with TBI used significantly fewer MSTs overall than did controls, but this effect was due only to differences in high-intimacy conversations. Participants with TBI showed evidence of sensitivity to the social context, as they used more MSTs per t-unit in the most intimate conversation than they did in the most superficial conversation, but did not adapt MST use to the same extent as controls, and evidenced a significantly different pattern of MST types across conversations, supporting the second hypotheses of this study and partially supporting the third.

The findings suggest that individuals with TBI are capable of recognizing social cues related to conversation intimacy level – at least in a highly supportive context where topics are explicit – and also that they are able to appreciate that a corresponding change in language is necessary, even if they are unable to adjust word choices to the extent needed. This was consistent with a previous study by Togher, Hand, and Code (1997) in which participants with TBI adjusted their conversation behaviors, including the amount of information they gave and the conversational burden they assumed, depending on the conversational context, in that case a change in conversational partner.

The types of MSTs used may also be important. In the present study, individuals with TBI and controls used more cognitive-state terms than any other category, regardless of conversation intimacy level. This finding is consistent with a previous investigation of adult discourse (Adrian, Clemente et al. 2005). As cognitive-state terms are later developing than MSTs related to beliefs or desires (Bretherton and Beehly 1982), the finding that adults with TBI used this type of MST confirms that they have not lost basic ToM skills developed in childhood. The two groups, however, used emotional-state terms differently across intimacy levels. In superficial conversations, control participants, on average, used very few emotional-state terms (11.90 % of all MSTs used); whereas, in the intimate conversations, 25% of all MSTs used were emotional terms. This makes sense given the nature of the RCIT questions, as the superficial questions would be expected to elicit statements about facts rather than feelings. By contrast, participants with TBI used a higher percentage of emotional-state terms in the superficial conversations (36.92%) compared to the intimate conversations (17.97%). This is consistent with common anecdotal reports that individuals with TBI often disclose inappropriately intimate information in casual contexts (Brooks, Campsie et al. 1986; Bond and Godfrey 1997). It makes sense that adults with TBI would be perceived as inappropriate if they were discussing feelings and emotions more prominently in conversations about hobbies and work than in conversations about their greatest fear or happiest childhood memories. While discussion of emotions in very superficial conversations may be perceived as inappropriate by partners, a lack of emotional discussion in more personal conversations may result in a perceived lack of intimacy between partners. Perhaps this is one reason conversations with adults with TBI have been rated as significantly less rewarding than those with typical peers (Bond and Godfrey 1997). Further, previous research has shown reduced emotional empathy in adults with TBI compared to uninjured peers, suggesting that individuals with TBI have difficulty understanding and experiencing the emotions of others (Williams and Wood 2010). Perhaps reduced use of emotional words in conversation is evidence of such an impairment in everyday life.

It is interesting to consider possible explanations for between-groups differences in quantity and quality of ToM-related word use. One possibility is that adults with TBI used fewer MSTs because they had impoverished vocabularies, or perseverated on the same words in all three conversations. This is unlikely to be the case, as the TBI and control groups did not differ in total number of words or lexical diversity in either Level 1 or Level 3

conversations. Also, lexical diversity was in fact greater in the shorter, more superficial conversations. This pattern is typical in conversations because longer conversations allow for repeated use of function words, reducing the ratio of different words to total words (Scott and Windsor 2000).

Group differences in MST use might be accounted for by intellectual differences, as participants with TBI had lower K-BIT scores than those of individuals in the comparison group. This explanation is unlikely however, as there is evidence that social intelligence can be dissociated from other aspects of intelligence (Thorndike, 1920) and previous research has reported dissociations between general intelligence and ToM (Baron-Cohen, Leslie, and Frith 1985, Baron-Cohen, et al. 2001). In addition, despite having generally lower intelligence scores, the participants with TBI did not differ from the comparison group in any other language measure, including lexical diversity.

An alternative explanation for between-groups differences is that participants in the TBI and control groups had different relationships with their conversation partners, given that several individuals in the TBI group chose care providers as partners. Relationship status has been found to play a key role in conversation in adults with TBI (Togher, Hand et al. 1996), specifically the difference between a researcher partner and a close friend or family member. Perhaps participants with TBI perceived themselves to have a lower status than that of their partner if that person was a caregiver on whom the participant relied on for daily support.

Two aspects of this study diminish the likelihood that partner relationships were responsible for group differences in MST use. First, relationships between control participants and their partners were quite varied, and included coworkers, personal friends, and relatives, and yet patterns of MST use were the same for each participant, suggesting that the nature of the relationship with partners did not influence MST use in the comparison group. Second, the conversation task supported equal status between partners, as it was designed to elicit reciprocal personal disclosure.

Group differences could reflect a lack of declarative knowledge about ToM in the TBI group, but this also is unlikely. Participants presumably developed typical social cognition prior to their injuries (none had any history of neurological, psychiatric, or learning disorders and all were employed and had social relationships), and there is evidence that individuals injured after age 9 years have declarative knowledge about mental states (Turkstra, Dixon et al. 2004). Also, even the participant with the fewest MSTs, who used none in the low-intimacy conversations, used 19 words referring to thoughts, the latest developing form of MST, and one word related to emotions in the high-intimacy conversation. For example, this participant discussed that he “*knew* how to play chess” and could “*remember* Topeka, Kansas.”

One potential confounding factor was group differences in adherence to the RCIT questions. Participants were told to use the question lists as “conversation starters” and that they did not have to exclusively discuss topics related to the questions presented. Individuals with TBI are known to have problem staying on topic (Snow et al. 1997) and might have missed talking about the higher-intimacy topics altogether. This did not seem to be the case, however, as comments by participants were equally on topic in both groups. Also, both groups did increase the frequency of MST use in the conversations in which they were given the most intimate question list, indicating a shift in topic intimacy. A related potential confound was perseveration by participants with TBI, i.e., so they adhered to the questions but repeated their comments. Again, this explanation is unlikely, as the groups did not differ in the total number of topics initiated or the percentage of utterances related to RCIT

questions, suggesting that the dyads discussed a similar variety of topics and that they were talking about the provided topics to a similar extent.

As the preceding explanations for between-groups differences in MST use seem unlikely, we propose that the results reflect a core deficit in either the ability to recognize context cues signaling changes in topic intimacy level (impaired social perception), or limitations in the ability to change behavior in response to these cues (executive dysfunction). It also may be some combination of these, and both types of deficits could be exacerbated by limitations in processing speed, which would be more apparent in a dynamic conversation than on typical static-image ToM tests. There is some evidence in support of each of these accounts. As discussed in the introduction, several prior studies have shown that individuals with TBI have impairments in ToM on laboratory-based tasks, including a prior study of MST use in which it was linked to scores on a ToM test (Stronach and Turkstra 2008). This lends support to the notion of a core deficit in social perception. The evidence related to EFs is less clear. While some studies have shown correlations between social cognition task performance and EF measures in adults with TBI (Channon and Watts 2003; Henry, Phillips et al. 2006) and between processing speed and pragmatic communication ability (McDonald, Bornhofen et al. 2006; Douglas 2010) others have reported a dissociation between EFs and social cognition (Bach, Happé et al. 2006; Havet-Thomassin, Allain et al. 2006; Muller, Simion et al. 2010). It may be that the relation of EFs and processing speed to social cognition depends on the aspect of each that is affected in a given patient (Samson, Apperly et al. 2007), or on the genre of communication, as tasks such as conversation might be expected to demand more self-regulation, metacognitive skills, and speed than tasks like story re-telling or picture description.

Limitations

The study sample size was small and comprised of only males with severe TBI, which limits the ability to generalize these findings to a larger clinical population. Future studies should consider effects of sex and gender (Maccoby 1988), particularly given evidence of sex-related differences in social cognition beginning early in life (Bosacki 2000; Walker 2005).

Another limitation of this study was that the two groups were not matched for IQ. As one participant with TBI could not complete the K-BIT, it was not possible to statistically compare the differences in IQ across groups; however, the scores were lower in those with TBI than in peers.

A third limitation of this study was the use of the RCIT as an elicitation task. The RCIT was chosen as a compromise between a typical discourse task such as story retelling, which permits a high degree of experimental control but has low ecological validity, and extemporaneous conversation, which is ecologically valid but has no control for factors such as differences in interests and shared knowledge across dyads. Use of the RCIT permitted some control over conversation topics across different dyads, so that data would be comparable, and minimized the potential confound of executive function impairments in the TBI group by providing general guidelines for interactions. The cost was that the RCIT question-answer format guided the conversations, so they may have been more structured than conversations in everyday life. Further, the RCIT was designed to help two strangers become familiar with one another, while the participants comprising each dyad in this study knew each other well. Familiarity with suggested topics is unlikely to account for between-groups differences, however, as participants in both groups had familiar partners and dyads in both groups commented during the superficial condition that they hadn't actually known the information shared by their partners.

A final potential limitation of this study was that no formal ToM tests were administered, so that it was not possible to compare ToM scores to MST use, as was done by Stronach and Turkstra (2008). This would be a useful next step in a larger sample, in which the relative contribution of factors such as executive function also could be considered.

Summary

Impairments in social communication are common, chronic problem in adults with moderate-to-severe TBI (Coelho et al. 2005; Struchen et al. 2008). Research in the area of social cognition has provided insights into social problems among adults with TBI, and offers a new perspective from which to examine conversation behaviors. In this study, adults with TBI used fewer thought- and feeling-related words in conversation, when compared to peers without TBI, and tended to use these words in inappropriate contexts. The results lend quantitative support to common caregiver complaints of egocentrism and lack of partner sensitivity among adults with TBI. The extent to which these behaviors represent impaired social cognition vs. executive dysfunction will be an important question to address in future research, so that treatment may more effectively target the underlying mechanisms of social communication problems and improve social outcome for adults with TBI in the chronic stage post-injury.

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Appendix A. Modified Relationship Closeness Induction Task questions

LIST 1

- How old are you?
- Where are you from?
- Who else is in your family besides you?
- What work/school/community activity are you doing right now?
- What is your favorite activity (at work/school/in the community)? Why?

LIST 3

1. If you could have one wish granted, what would that be?
2. Is it difficult or easy for you to meet people? Why?
3. Describe the last time you felt lonely.
4. What is one recent emotional experience you've had?
5. What is one of your biggest fears?
6. What is your most frightening childhood memory?
7. What is your happiest early childhood memory?
8. What is one thing about yourself that most people would consider surprising?
9. Tell me one thing about yourself that most people who already know you don't know.

10. What is one recent accomplishment that you are proud of?

Appendix B. List of mental state terms. c = Cognitive term; e = Emotion term; d = Desire term

accept _c	brilliant _c	favorite _c	hate _e	matter _c	react _c	sore _e	truth _c
accuse _c	care _e	fear _e	have to _c	mean _c	real _c	sorry _e	try _c
adverse _c	catch _c	feel _c	honest _c	memory _c	realistic _c	sound _c	twisted _c
afraid _e	certain _c	figure out _c	hope _d	mental _c	realize _c	straight _c	understand _c
agree _c	click _c	fine _c	horrified _e	miss _e	relax _c	strainght on _c	upset _e
all right _c	concept _c	firm _c	hot _c	need _c	remember _c	strange _c	want _d
ambition _c	consider _c	forget _c	(attractive)	nice _c	remind _c	struggle _c	well _c
apparent _c	cool _c	freak out _e	hurt _e	normal _c	responsible _c	study _c	wise _c
assume _c	crazy _c	frightening _e	idea _c	nuts (crazy) _c	right _c	stupid _c	wish _d
attention _c	crush _e	fun _e	inquisitive _c	obviously _c	rude _c	suck _e	wonder _c
attractive _c	decent _c	funny _c	intelligent _c	offend _e	sad _e	suppose _c	worry _c
awful _c	deep _c	“get a kick	interesting _c	opinion _c	say _c	sure _c	worst _c
bad _c	deserve _c	out of” _e	know _c	outlandish _c	scared _e	suspect _c	wrong _c
believe _c	different _c	“get over” _e	learn _c	overlook _c	see _c	take _c	
best _c	difficult _c	glad _e	like _e	perceive _c	self-centered _c	talk _c	
better _c	dream _d	good _c	logical _c	pissed off _e	serious _c	talkative _c	
bitch _c	easy _c	gotta _c	lonely _e	point (idea) _c	shallow _c	taught _c	
blame _c	emotional _c	guess _c	look _c	poor _c	should _c	tell _c	
bogus _c	enjoy _e	handle _e	(understand)	prefer _d	show _c	thank _e	
bother _e	excellent _c	happy _e	look past _c	prepare _c	shy _c	think _c	
brave _c	expensive _c	hard _c	love _e	proud _e	simple _c	thoughts _c	
				rather _d	sluttish _c	tripped out _c	
				rational _c	smart _c	true _c	

What this paper adds**What is already known on this subject?**

Following moderate-to-severe traumatic brain injury, individuals frequently experience chronic social communication impairments and there is evidence that these problems stem in part from specific impairments in social cognition. While there is evidence from laboratory tasks that individuals with TBI have impairments in one aspect of social cognition, theory of mind, it is unclear how impairments in theory of mind manifest in conversation.

What this study adds

This study provides evidence of theory of mind impairment in the conversations of men with TBI as participants used fewer words that reflect theory of mind (e.g. thought and feeling words) than did peers without TBI. It was also found that participants with TBI also used such words inappropriately for the context.

Figure 1. Change in use of mental-state terms across conversation intimacy levels for TBI group (solid line) and Control group (dotted line).

Figure 2. Change in mental-state term category from Level 1 (Figure 2a) to Level 3 (Figure 2b) for TBI group (black bars), and Control group (grey bars).

Table 1

Participant characteristics.

Participant	Age at Test (years:months)	Educational Level	K-BIT Composite Scaled Score	Age at Injury	Injury Mechanism	Injury Severity	Neuroimaging Results
TBI 1	35;9	High school graduate	88	18;3	MVA	Severe	Severe temporoparietal hematoma, white matter damage
TBI 2	50;4	Vocational Training	80	33;7	MVA	Severe	Multiple hemorrhagic contusions to frontal and temporal lobes, intraventricular bleeding
TBI 3	39;5	Some college	93	32;8	MVA	Severe	Shear injuries to corpus callosum, damage to left frontal and left temporal lobes
TBI 4	44;0	College graduate	85	35;0	MVA	Severe	Subdural hematoma left medial temporal lobe and medial cerebellum
TBI 5	53;1	Some college	Not able to complete	19;6	MVA	Severe	Not available
Control 1	25;5	High school graduate	111				
Control 2	50;1	College graduate	101				
Control 3	36;0	Some college	96				
Control 4	42;5	Some college	95				
Control 5	62;11	College graduate	122				

K-BIT = Kaufman Brief Intelligence Test; MVA = motor vehicle accident.

Table 2

Partner characteristics and relationship to participant.

Participant	Partner Relationship	Partner Education	Partner K-BIT Composite Scaled Score
TBI 1	Indirect care provider	College graduate	127
TBI 2	Indirect care provider	College graduate	117
TBI 3	Personal friend	Some college	98
TBI 4	Direct care provider	Some college	106
TBI 5	Direct care provider	Some college	127
Control 1	Personal friend	Some college	88
Control 2	Coworker	College graduate	108
Control 3	Personal friend	Some college	98
Control 4	Coworker	Some college	91
Control 5	Nephew	Professional school graduate	134

KBIT = Kaufman Brief Intelligence Test.

Table 3

Standard Language Measures and MST data.

Group		MST per T- Unit	Total Number of Utterances	Total Number of Words	Mean Length of Utterance	Type Token Ratio	Percent Intelligent Utterance	Mazes per T- Unit
TBI	Level 1	0.43 (0-.71)	24 (19-55)	140 (81-386)	5.25 (3.36-7.22)	.59 (.40-.74)	98 (95-100)	0.18 (0.04-0.21)
	Level 3	0.51 (0.27-1.01)	87 (47-144)	663 (213-1360)	6.66 (3.27-9.29)	.37 (.22-.60)	99 (97-100)	0.09 (0.04-0.29)
Control	Level 1	0.33 (0.30-0.66)	25 (17-35)	152 (107-191)	5.43 (4.96-7.23)	.61 (.53-.68)	100 (88-100)	0.20 (0.00-0.35)
	Level 3	0.76 (0.68-1.27)	87 (77-125)	807 (642-936)	7.48 (6.81-8.99)	.37 (.30-.45)	99 (96-100)	0.19 (0.12-0.40)

Data are medians with range in parentheses. MST = mental state term; T-Unit = terminable unit.