Published in final edited form as:

Neuropsychol Rehabil. 2019 June ; 29(5): 789–803. doi:10.1080/09602011.2017.1333012.

Detection of text-based social cues in adults with traumatic brain injury

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Abstract

Objectives: Written text contains verbal immediacy cues - word form or grammatical cues that indicate positive attitude or liking toward an object, action, or person. We asked if adults with moderate-severe traumatic brain injury (TBI) would respond to these cues, given evidence of TBI-related social communication impairments.

Methods: 69 adults with TBI and 74 healthy comparison (HC) peers read pairs of sentences containing different types of immediacy cues (e.g., speaker A said “*these Canadians*” vs. B said “*those Canadians*.”) and identified which speaker (A or B) had a more positive attitude toward the underlined entity (Task 1); and pairs of sentences comprised of a context sentence (e.g., Fred is asked, “Did you visit *Joan* and Sue?”) and a statement sentence (Fred says, “I visited Sue and *Joan*.”) and were asked to indicate how much Fred liked or disliked the underlined words (Task 2).

Results: HC group scores were significantly higher on Task 1, indicating more sensitivity to cues. On Task 2, TBI and HC group ratings differed across cue types and immediacy types, and the TBI group appeared to have less sensitivity to these cues.

Conclusions: Findings suggest that TBI-related impairments may reduce sensitivity to subtle social cues in text.

Keywords

language; adults; brain injuries; emotions; humans; writing

Social problems are a well-documented outcome of TBI in adulthood, including problems with interpersonal communication (Bond & Godfrey, 1997; Dahlberg et al., 2006; Dardier et al., 2011; Rousseaux, Verigneaux, & Kozlowski, 2010), loss of friends and employment

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Declaration of Interest

The authors have nothing to declare.

(Engberg & Teasdale, 2004), and reduced involvement in social groups and leisure activities (McLean, Jarus, Hubley, & Jongbloed, 2014). Also well documented in adults with TBI is insensitivity to social cues, particularly cues to others' mental states (e.g., Channon & Crawford, 2010; McDonald, 2013; McDonald & Flanagan, 2004; Turkstra, 2008). Mentalizing problems not only are evident on laboratory-based tasks, but also may contribute to the real-world social problems commonly observed in adults with TBI (Byom & Turkstra, 2016; Rigon, Turkstra, Mutlu, & Duff, 2017; Ubukata et al., 2014).

Studies of social cue perception generally involve asking adults with TBI to identify thoughts and intents of story characters in written narratives or video scenes (e.g., Bosco, Angeleri, Sacco, & Bara, 2015; Channon & Crawford, 2010; Honan, McDonald, Gowland, Fisher, & Randall, 2015; McDonald, 2013), in which social information is extracted from event sequences. While studies using social stories have been informative, social cues are also evident at more microscopic levels, in grammatical form and word order within sentences. Study of these within-sentence cues could inform our understanding of story-level impairments and help identify additional situations in which impairments could present social challenges.

Verbal immediacy, the use of "concrete, personal, involved, experiential language with a focus on the here and now" (Borelli et al., 2011), communicates the degree of intensity, directness, and closeness of an interaction (Mehrabian, 1967; Pennebaker & King, 1999). Language with high immediacy has increased use of linguistic forms such as first-person singular pronouns "I," "me," and "my"; inclusive pronouns "these" instead of "those"; naming one person before another in a list (e.g., "Did you visit Joan and Sue?" vs. "Did you visit Sue and Joan?"); and present tense words (Mehrabian, 1967, 1972a; Pennebaker & King, 1999). These linguistic cues help individuals implicitly communicate aspects of affect, evaluation, or preference that are difficult or potentially unacceptable to convey explicitly in words, such as saying that one likes one group more than another (Mehrabian, 1972a). Individuals use these cues consistently across interactions, which in turn can help characterize communication style and predict personality (Pennebaker & King, 1999; Ireland & Mehl, 2014).

Early research into verbal immediacy using written stimuli provided robust evidence that typical adults produce immediacy cues and infer social meaning from them in both spoken and written language (Mehrabian, 1967, 1968, 1972a, 1972b). Since then, a growing body of literature has explored the communicative and psychological consequences of the use of verbal immediacy in social interactions in various contexts, from spoken discussions among married couples (Simmons et al., 2005) to written posts on social media (Bazarova et al., 2012) (see Pennebaker et al., 2003 for a review). These studies have suggested that high immediacy communication signals familiarity in public communication on social media (Bazarova et al., 2012), closeness in relationships (Pennebaker & King, 1999), and informality of the setting (Biber, 1988; Pennebaker & King, 1999). The use of language with high immediacy has also been associated with a number of positive social outcomes, including compliance and persuasion (Mehrabian, 1968; Riggio et al., 1989), student participation and affective and cognitive learning in education (Gorham, 1988; Allen et al.,

2006; Khan, 2007), effective problem solving and satisfaction among married couples (Simmons et al., 2005), and satisfaction and team cohesion in sports teams (Turman, 2008).

The body of literature on verbal immediacy suggests that sensitivity to immediacy cues is relevant to overall social functioning. In this study, we explored the extent to which adults with TBI showed this sensitivity, specifically investigating whether they would make relational judgments based on verbal immediacy cues in written communication. The study used the research paradigm employed in early research, in which individuals made “liking” judgments based on written sentences presented to them (Mehrabian, 1967, 1968, 1972a, 1972b). It could be argued that this paradigm does not capture language use in contemporary social interactions, given changes in language patterns over time and increased use of expressive and contextual markers (e.g., emoticons and hashtags), the early research provided the most comprehensive framework for studying verbal immediacy and we expected it to serve as a strong foundation for a first understanding of social perception in text-based communication among individuals with TBI.

Our study focused on written text because it has become an increasingly common form of interpersonal communication and has been understudied in adults with TBI. Each day, over six billion text messages are sent in the United States, with the typical person sending or receiving 35 text messages per day (O’Grady, 2015). Important school, work, and social activities are conducted via electronic written communication, which plays a critical role in everyday goals from coordinating complex work tasks via email (Meulenbroek, Turkstra, & Bowers, 2015) to making a positive impression when texting someone to ask them out on a date (Fullwood, Quinn, Chen-Wilson, Chadwick, & Reynolds, 2015). Individuals with TBI may be even more likely than their peers to rely on written communication, given the potential benefits of online written interactions for individuals who are physically and socially isolated (Brunner, Hemsley, Palmer, Dann, & Togher, 2015) and the use of written text as a strategy to support cognitive function in everyday life (Velikonja et al., 2014). Thus, lack of response to written cues, particularly written social cues, could have important negative consequences for adults with TBI.

In this study, we investigated whether adults with TBI would make “liking” judgments based on verbal immediacy cues in written sentences. We focused on written text because it has become an increasingly common form of interpersonal communication and has been understudied in adults with TBI. Each day, over six billion text messages are sent in the United States, with the typical person sending or receiving 35 text messages per day (O’Grady, 2015). Important school, work, and social activities are conducted via electronic written communication, which plays a critical role in everyday goals from coordinating complex work tasks via email (Meulenbroek, Turkstra, & Bowers, 2015) to making a positive impression when texting someone to ask them out on a date (Fullwood, Quinn, Chen-Wilson, Chadwick, & Reynolds, 2015). Individuals with TBI may be even more likely than their peers to rely on written communication, given the potential benefits of online written interactions for individuals who are physically and socially isolated (Brunner, Hemsley, Palmer, Dann, & Togher, 2015) and the use of written text as a strategy to support cognitive function in everyday life (Velikonja et al., 2014). Thus, lack of response to written

cues, particularly written social cues, could have important negative consequences for adults with TBI.

The study involved two tasks. Task 1 was a comparison task in which participants indicated which of two objects were liked more by the writer, referred to here as the *source*. Task 2 was a rating task in which participants indicated the extent to which the source liked an object (person, place, or thing, or attributes of these). For both tasks, we hypothesized that adults with TBI would be less sensitive than their uninjured peers to within-sentence immediacy cues such as inclusive pronouns or order of objects within a list.

Hypotheses

The first hypothesis was that individuals with TBI would be less accurate than uninjured adults in detecting immediacy cues, showing impaired sensitivity to the presence of immediacy cues. This hypothesis was based on evidence of impaired social cue perception in adults with TBI. The second hypothesis was that between-group differences would vary by cue type. The basis of this hypothesis was the finding by Mehrabian (1972a) that cue types varied in salience as social cues and in their effects on mentalizing. Specifically, we expected individuals with TBI to be disproportionately less sensitive to cues that have low salience for typical adults.

Methods

Participants

Participants were recruited from a larger study of social cognition and communication in adults with TBI. Inclusion criteria included English as a primary language, normal hearing, no history of medical or neurological disease affecting the brain (pre-morbidly for those with TBI), and no history of a language and/or learning disability (pre-morbidly for those with TBI). Participants with TBI had a moderate-to-severe injury as defined by nationally accepted criteria (Malec et al., 2007) and were at least six months post injury and out of posttraumatic amnesia. To rule out difficulty with reading comprehension as a contributor to performance on experimental tasks, participants were excluded if they obtained a score of less than 6 on the Reading section of the Western Aphasia Battery Bedside Screening, indicating that they did not pass the comprehension portion. Applying this criterion resulted in the exclusion of two participants from the comparison group and one from the TBI group. One additional participant in the TBI group was excluded because her family member had discussed a similar task with her and gave instructions about how to complete it.

The final sample included 68 adults with TBI (28 women) and a healthy comparison (HC) group of 68 adults (33 women) collected across two sites located in Madison, WI and Iowa City, IA. Demographic data are summarized in Table 1. All participants were recruited from the community and from participants in previous studies who had consented to be re-contacted, and HC participants were recruited to match adults with TBI for age, sex, and education. There was no significant difference between groups in age, $t(134) = 0.10$, $p = .92$, or education, $t(133) = 1.26$, $p = 0.21$. The mean age of the groups was 43.28 years for the TBI group, ranging from 23 to 65 years, and 43.52 years for the comparison group, ranging

from 18 to 65 years. Individuals with TBI ranged 12–22 ($M = 14.75$) and individuals in the comparison group ranged 12–19 ($M = 15.18$) in years of education. All but five participants were Caucasian: three males and one female in the comparison group self-identified as African American; and female participant in the TBI group self-identified as “other.”

Tasks and Procedures

Participants completed the two study tasks presented here as part of a battery of tests for the larger study. All procedures were approved by the relevant institutional review boards. Tasks were based on original tasks created by Mehrabian (1967, 1968), with additional stimuli generated with permission of the author (Mehrabian, 2011), as only sample stimuli from the original task were available. Stimuli were written at a fourth-grade reading level. Tasks were pilot tested on 38 undergraduate students, ages 18–22 years (26 women), and one item was removed (see *Task 2* below).

Task 1. Liking Comparison (Mehrabian, 1967). Participants were presented with a typed list of sentence pairs with four types of contrasting immediacy cues: distance, time, order of occurrence, duration. Table 2 shows the four types of cues and sample stimuli. The experimenter read the following instructions:

On these sheets of paper, you will find 16 pairs of statements by two speakers (speaker A and speaker B) about an identical experience involving a person, object, action, or event. Please keep in mind that we are assuming that both speakers are sharing an identical experience. In each pair of statements, a person’s name, an object, an action, or an event has been underlined. For each pair of statements, we would like you to indicate the speaker (A or B) whom you think has a more positive attitude toward the underlined entity.

Participants were given one point for each correct response and could obtain a maximum accuracy score of 16. As stated in Hypothesis 1, we expected accuracy scores to be significantly lower in the TBI group than the comparison group. Additionally, Hypothesis 2 predicted that group differences would depend on cue type.

Task 2. Liking Rating (Mehrabian, 1972b). Participants were presented with pairs of sentences composed of a context sentence (immediate or distinct) and a statement sentence (immediate or non-immediate). Six types of cues to indicated liking of a person or object: order of occurrence, duration, probability, communicator participation, object participation, communicator-object participation. Table 3 lists the six types of cues presented. In the table, sentence A and B are the immediate and non-immediate versions, respectively, but order was randomized for the study task. Stimuli included all four combinations of immediate vs. non-immediate pair types:

1. Immediate statement (IS) in a non-immediate context (NC): Fred is asked, “Did you visit Sue and Joan? Fred says, “I visited Joan and Sue.”
2. Non-immediate statement (NS) in a non-immediate context (NC): Fred is asked, “Did you visit Sue and Joan? Fred says, “I visited Sue and Joan.”

3. Immediate statement (IS) in an immediate context (IC): Fred is asked, “Did you visit Joan and Sue?” Fred says, “I visited Joan and Sue.”
4. Non-immediate statement (NS) in an immediate context (IC): Fred is asked, “Did you visit Joan and Sue? Fred says, “I visited Sue and Joan.”

Task stimuli consisted of 24 pairs of sentences representing all four sentence combinations across the six cue types. During pilot testing, one NC-NS item was eliminated because of high error rates. Thus, there were only five exemplars of this pair type and six for all other pair types, resulting in a final list of 23 pairs of sentences.

After each pair of sentences, participants were presented with a with a Likert-type rating scale. The rating scale was from -3 (dislike very much) to $+3$ (like very much). The experimenter read the following instructions:

For this next part of the task, please circle the number that corresponds to how much Fred likes or dislikes the underlined words.

Liking ratings were recorded for each item. Mehrabian (1972b) found that speakers assigned the most positive attitude toward the object in the NC+IS combination and the most negative attitude toward the object in the IC+NS pairs. Ratings for the two remaining permutations were intermediate between these two extremes.

Results

For hypothesis 1, Task 1 data were analyzed using a fixed-effects analysis of covariance (ANCOVA), including total number of statements with immediacy cues selected by the participant as being immediate as the response variable (0 to 16), group (TBI vs. HC) as the between-groups factor, and site of data collection as a covariate in order to control for inter-site differences. *Alpha* criteria were .05 for significant results and .10 for non-significant but marginal results in all analyses. Our analysis showed support for Hypothesis 1: HC participants ($M = 13.44$, $SD = 2.018$) were significantly more likely than participants with TBI to choose statements with immediacy cues as reflecting positive attitudes, $M = 12.66$, $SD = 1.94$, $F(1,133) = 5.22$, $p = .02$ (see Figure 1).

To test Hypothesis 2, we analyzed data from Task 2 using a mixed-model ANCOVA, including ratings (-3 to 3) for each statement as the response variable, participant ID as a random effect, group (TBI vs. HC) as the between-groups variable, cue type (order of occurrence, duration, probability, communicator participation, object participation, communicator-object participation) as the within-participants factor, and site of data collection as a covariate. This analysis was followed by pairwise comparisons using Bonferroni correction for multiple comparisons (adjusted *alpha* level = $.05/6 = .0083$) for each cue type. The results provided partial support for Hypothesis 2: there was a significant interaction between group and cue type, $F(5,694.2) = 2.82$, $p = .016$. However, group differences for each cue type were not significant (Figure 2).

Based on the findings just described, we generated a third hypothesis: that adults with TBI would show less sensitivity to a cue mismatch between the context of a statement and the

statement itself. Prior work (Mehrabian, 1968, 1972b) argued that statement and context immediacy interact: an immediate statement in a non-immediate context may be interpreted as a positive preference toward the subject, while a non-immediate statement in an immediate context may signal a negative preference. We expected reduced sensitivity to the effects resulting from the combination of the two types of cues in the TBI group. Data were analyzed with a mixed-model ANCOVA, with ratings (−3 to 3) for each statement as the response variable, participant ID as a random effect, group (TBI vs. HC) as the between-groups variable, context immediacy (immediate, non-immediate) and statement immediacy (immediate, non-immediate) as within-participants variables, and site of data collection as a covariate. Bonferroni correction was used for all pairwise comparisons, and adjusted alpha levels are provided for each analysis.

Analysis revealed a significant interaction effect between group and context immediacy, $F(1,133) = 8.40$, $p = .004$, and between group and statement immediacy, $F(1,132.4) = 19.65$, $p < .001$ (Figure 3). Although pairwise comparisons showed the effects of context and statement immediacy on both groups to be similar, we found effect sizes for the HC group (Cohen's $d = 1.40$ for statement immediacy; .53 for context immediacy) to be higher than the TBI group (Cohen's $d = .97$ for statement immediacy; .42 for context immediacy), indicating a reduced sensitivity to each cue type by individuals with TBI. We also identified a marginal interaction among group, context immediacy, and statement immediacy, $F(1,132.8) = 2.90$, $p = .091$.

Analysis of data from both groups with Bonferroni correction (adjusted α level = $.05/3 = .0167$) showed the pattern predicted by prior work. The speaker was seen as having more positive attitude when immediate statements were used in non-immediate contexts than when immediate statements were used in immediate contexts. Immediate statements in immediate context were seen as more positive than non-immediate statements in non-immediate contexts. Finally, non-immediate statements in immediate contexts were seen as more negative than non-immediate statements in immediate contexts. This analysis was repeated with data from each group (adjusted α level = $.05/6 = .0083$), and revealed that the pattern existed for both the healthy participants and the individuals with TBI (Figure 4).

To gain a better understanding of group differences in responses to different combinations of context- and statement-immediacy cues, we compared ratings by TBI and HC groups for each context-statement pair. This comparison showed that TBI group responses to all context-statement pairings except for non-immediate statement in non-immediate context were significantly lower than those of the HC group (Figure 5).

Discussion

Evidence of impaired social perception in adults with TBI has been derived primarily from studies in which cues are presented in the context of story narratives or scenes. Social cues are also present within sentences, however, and the response of adults with TBI to these cues is not known. This study focused on written cues because of the importance of brief written text in everyday social life, and potential for even small problems to have big social effects. We developed three hypotheses regarding group differences in responses to verbal cues and

differences across cue and immediacy types, and tested these hypotheses using two tasks: a liking comparison task and a liking rating task, both of which incorporated written cues to a source's feelings about a person or object. Results provided partial support for the study hypotheses, as discussed next.

Task 1. Liking Comparison

Results for the liking comparison task were as predicted by Hypothesis 1. When compared to uninjured adults, participants with TBI were significantly less likely to respond to verbal immediacy cues. This finding suggests that processing of microstructural social cues may be impaired in some adults with TBI, which could affect not only how people with TBI understand cause and effect in everyday communication but also how what those causal statements imply about relationships between others. Accuracy scores were high in both groups, showing that participants did respond to most cues, but subtle social cues can have significant effects on behavior (Doohwang & LaRose, 2011; Haley & Fessler, 2005), so these small differences may be socially significant.

There is some debate about mechanisms underlying errors on social tasks in adults with TBI. Although the study was not designed to identify mechanisms underlying performance, the results may be relevant to that debate. The two most commonly cited mechanisms are impaired social cognition and impaired working memory (WM). Evidence for the social cognition account includes links between poor performance and atypical function in brain regions thought to be critical for social cognition (Newsome et al., 2010; A. Rigon, Voss, Turkstra, Mutlu, & Duff, 2017; Ryan et al., 2016), and evidence of poor performance on some tasks even when WM demands are minimized (Rigon, Turkstra, Mutlu, & Duff, 2016). Social cognition includes the ability to infer others' mental states, and immediacy cues are cues to the thoughts and feelings of others. Like other mental-state cues, immediacy cues are implicitly learned and used; are processed rapidly; and can represent abstract, complex social constructs. Our findings of diminished response to immediacy cues in adults with TBI are consistent with other evidence of impaired mentalizing in adults with TBI (Channon & Crawford, 2010; Honan et al., 2015; Martin-Rodriguez & Leon-Carrion, 2010; McDonald, 2013; Spikman, Timmerman, Milders, Veenstra, & van der Naalt, 2012), and suggests that social cognition may play a role in social cue perception errors.

Evidence for the WM account includes intact performance on social cognition tasks when WM demands are minimized (Honan et al., 2015) vs. errors when WM demands are increased (Turkstra, 2008); correlations between social cognition task scores and WM test scores (Henry, Phillips, Crawford, Ietswaart, & Summers, 2006); intact performance on social cognition tasks that minimize WM demands, such as implicit emotional associations (McDonald, Saad, & James, 2011). WM impairments also are common in people with TBI (Busch, McBride, Curtiss, & Vanderploeg, 2005; Perlstein et al., 2004; Serino et al., 2006), and contribute to poor performance of adults with TBI on non-social language tasks (Moran & Gillon, 2004; Turkstra, 1999). A WM explanation cannot be ruled out for any task that involves comparing two items (e.g., sentence A vs sentence B), but WM is an unlikely explanation for our results: stimuli were short, simple sentences, without embedded clauses or other grammatical structures known to increase WM load; both sentences were in view at

all times; instructions were short and simple; and participants could complete the task at their own speed. All of these factors would minimize WM effects. Adults with TBI had high scores overall, so frank impairments in social cognition also are an unlikely account.

A third potential mechanism not typically discussed in TBI research is selective attention (also called *executive attention*), which often is impaired in adults with moderate-severe TBI (Ben-David, Nguyen, & van Lieshout, 2011). It may be that adults with TBI are capable of detecting cues, but are sometimes distracted by irrelevant features of the sentence, their own thoughts (e.g., “mowing the lawn” might trigger thoughts about needing to mow one’s own lawn), or external stimuli in the test setting. This account might explain why adults with TBI missed some cues but not others. Selective attention impairments in turn have been attributed to slowed speed of processing (Ben-David et al., 2011) and cognitive fatigue (Ziino & Ponsford, 2006). Clinical supports might be the same across many of these mechanisms (e.g., increasing cue salience and allowing time to reflect and re-read would address most problems), so fine-grained analysis of mechanisms may not be necessary.

Task 2. Liking Rating

Results from our analysis of Task 2 data showed that detection of attitudes from textual communication depended on cue type and, as predicted by Hypothesis 2, that the two groups differed in their responses to different cue types. The interaction between cue type and group and the lack of significant between-group differences for each cue type suggest that impairment in social cognition resulting from TBI affects the ability to detect attitudes from some textual cues and not others, although more research is needed to establish exactly which cues present a challenge to individuals with TBI.

Our analysis also examined interaction of context and statement cues, as formulated by Mehrabian (Mehrabian, 1968). On Task 1, the comparison task, there was no context other than the name of the person holding the belief. By contrast, the first sentence of each item on Task 2 provided a context for the second. Mehrabian (1968) constructed the rating task specifically to examine context effects on response to liking cues, arguing that our judgments about others are influenced by context (e.g., we might be less critical of style errors in a paper if we know the author is a student vs. a faculty member). Our analysis showed that both individuals with TBI and their healthy peers integrated statement and context cues in their interpretations of attitudes from text following the pattern predicted by Mehrabian (Mehrabian, 1968), although we found individuals with TBI to be less sensitive to the interaction between these cues, particularly when context and statement cues were incongruent (e.g., a non-immediate statement in an immediate context). Although individuals with TBI may not always use context cues effectively (e.g., to understand implied meaning, (Ferstl, Guthke, & von Cramon, 2002) or interpret emotions, (Pettersen, 1991), their performance may be better with context cues than without (Crocker & McDonald, 2005; Zupan & Neumann, 2014). Perhaps even subtle cues context cues can support performance in this clinical group.

Limitations and Future Directions

Stimuli used here were based on experimental research in the 1970s and may not reflect the types of written language used in contemporary social interactions. Furthermore, further research is needed to establish the applicability of the findings to other forms of contemporary written communication, such as text messaging and e-mail, that involve the use of informal language and expressive and contextual markers, such as emoticons, hashtags, dynamic text, and so on. The presence of these additional, salient, and emotionally and contextually rich cues may override the effects of linguistic immediacy cues on mentalizing.

The present study used a subset of immediacy cues, which also include verbal behaviors such as using personal examples, asking questions, and praising others; as well as nonverbal behaviors such as reducing physical distance, using gestures, smiling, and using varied intonation (O'Sullivan, Hunt, & Lippert, 2004). These cues contribute to successful interpersonal communication in a variety of settings (Menchik & Tian, 2008), so reduced sensitivity to immediacy cues as a group may contribute to social problems in adults with TBI. Also, in real-life interactions these cues are likely to occur in complex patterns over time (Turkstra, Brehm, & Montgomery, 2006), so the problem may lie in integration of multiple cues rather than response to any single cue.

The ability to *produce* immediacy cues in interpersonal interactions was not studied here but is equally important, particularly when the goal is to make a positive impression on others, be likeable and accepted, or develop a relationship (Andersen & Andersen, 1987). The literature on immediacy cues may provide a framework for understanding some social behaviors of adults with TBI, such as violating interpersonal distance norms (Prutting & Kirchner, 1987), using fewer gestures (Jones & Turkstra, 2011), and showing a narrower range of facial and vocal affect than their uninjured peers (de Sousa, McDonald, & Rushby, 2012; Dethier, Blairy, Rosenberg, & McDonald, 2012), with resulting effects on interpersonal relationships.

The sample was relatively homogeneous in race and all were native English speakers. While there is no evidence to suggest that the phenomenon of immediacy would differ according to race or ethnicity, there may be cultural differences in words used to express immediacy in text. Replication of findings is necessary before results can be applied to different cultural groups or clinical populations.

Conclusion

Written text is ubiquitous in everyday life of many adults and a cornerstone of effective communication in today's online and texting culture. Subtle impairments at this basic level of social information processing could have negative consequences for adults TBI. The current study investigated how adults with TBI detected attitudes from written cues to immediacy, and found reduced levels of sensitivity to these cues, contributing to our understanding of social impairments in this clinical group.

Acknowledgement:

This work was supported by the National Center for Medical Rehabilitation Research (NCMRR) of the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) under Grant R01 HD071089.

The authors wish to thank Dr. Jee-Seon Kim for statistical advice, and Dr. Erica Richmond, Emily Hosokawa, Sarah Kraning, Joseph Wszalek, and the Turkstra lab and Duff lab members for their assistance with data collection and preparation for publication.

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Figure 1. Number of statements with immediacy cues that TBI and HC groups identified as being immediate in Task 1. (*) denotes significant differences at alpha level .05. Error bars represent standard error.

Figure 2.
Average statement rating by TBI and HC groups for each of the six cue types presented in Task 2. Error bars represent standard error.

Figure 3.

Average statement rating by TBI and HC groups for immediate and non-immediate context cues and statement cues. Error bars represent standard error.

Figure 4. Patterns of responses to different context-statement pairings for TBI and HC groups. (†) and (‡) denote significant differences at Bonferroni-corrected alpha levels .0167 and .0083, respectively. Error bars represent standard error.

Figure 5.

Group differences for each statement-context pairing. (*) denotes significant differences at Bonferroni-corrected alpha level .0125. Error bars represent standard error.

Table 1.

TBI participant characteristics. CVLT = California Verbal Learning Test (Delis, Kramer, Kaplan, & Ober, 2000), Trails B = Trailmaking Test Part B (Tombaugh, 2004), WAIS PSI = Wechsler Adult Intelligence Scale (Wechsler, 2008) Processing Speed Index. CVLT and Trails B scores are z-scores; WAIS PSI scores are scaled scores, M = 100, SD = 15.

	Control (n = 68)		TBI (n = 68)	
	Mean	SD	Mean	SD
Age in Years	43.52	14.55	43.28	13.91
Age Range	18–65	-	23–65	-
Years of Education	15.18	1.73	14.69	2.18
CVLT Immediate	56.6	12.71	46.34	14.21
CVLT Short Delay	0.56	0.93	0.23	7.13
CVLT Long Delay	0.54	0.89	-0.78	1.44
Trails A	0.72	1.55	-0.5	1.48
Trails B	0.55	1.42	-1.52	3.57
WAIS PSI	106.41	21.98	91.54	15.67

Table 2.

Immediacy cues included in Task 1. The target object in each sentence is underlined.

Cue Type	Example
Distance	A: I don't understand these <u>Canadians</u> .
<i>Type of demonstrative pronoun used</i>	B: I don't understand those <u>Canadians</u> .
Time	A: John and I go <u>fishing</u> regularly.
<i>Ongoing vs. past/future</i>	B: John and I will go <u>fishing</u> regularly.
Order of Occurrence	A: We went to visit <u>Jack</u> and Jane.
<i>Earlier indicates more immediate</i>	B: We went to visit Jane and <u>Jack</u> .
Duration	A: I saw <u>Vincent</u> mowing his lawn.
<i>Longer sentence indicates more immediate</i>	B: I saw <u>Vincent</u> .

Table 3.

Cues to liking and examples of sentences for each cue. Target objects are underlined.

Cue Type	Context	Statement
<i>Order of Occurrence</i>	A: Fred is asked, "Did you visit <u>Joan</u> and Sue?"	A: Fred says, "I visited <u>Joan</u> and Sue."
	B: Fred is asked, "Did you visit Sue and <u>Joan</u> ?"	B: Fred says, "I visited Sue and <u>Joan</u> ."
<i>Duration</i>	A: Fred is asked to write a long letter about <u>Bob</u> .	A: Fred writes a long letter about <u>Bob</u> .
	B: Fred is asked to write a short letter about <u>Bob</u> .	B: Fred writes a short letter about <u>Bob</u> .
<i>Probability</i>	A: Fred is asked if he takes <u>yoga classes</u> .	A: Fred says, "I take <u>yoga classes</u> ."
	B: Fred is asked if he would take <u>yoga classes</u> .	B: Fred says, "I could take <u>yoga classes</u> ."
<i>Communicator Participation</i>	A: Fred is asked, "Are you going to the <u>store</u> ?"	A: Fred says, "I am going to the <u>store</u> ."
	B: Fred is asked, "Is your friend going to the <u>store</u> ?"	B: Fred says, "My friend is going to the <u>store</u> ."
<i>Object Participation</i>	A: Fred is asked to write a letter and describe <u>Sue</u> 's personality.	A: In his letter, Fred describes <u>Sue</u> 's personality.
	B: Fred is asked to write a letter and describe some of <u>Sue</u> 's habits."	B: In his letter, Fred describes some of <u>Sue</u> 's habits.
<i>Communicator-Object Participation</i>	A: Fred is asked, "How are you and <u>Bob</u> doing in school?"	A: Fred says, " <u>Bob</u> and I are doing well in school."
	B: Fred is asked, "How are you doing in school?"	B: Fred says, "I am doing well at school."