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Empathic Responses to Affective Film Clips Following Brain Injury and the Association with Emotion Recognition Accuracy

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ABSTRACT

Objective: To compare empathic responses to affective film clips in participants with traumatic brain injury (TBI) and Healthy controls (HCs), and examine associations with affect recognition.

Design: Cross sectional study using a quasi-experimental design.

Setting: Multi-site study conducted at a post-acute rehabilitation facility in the USA and a University in Canada.

Participants: A convenience sample of 60 adults with moderate to severe TBI and 60 HCs, frequency matched for age and sex. Average time post-injury was 14 years (range: .5-37)

Main Outcome Measures: Participants were shown affective film clips and asked to report how the main character in the clip felt and how they personally felt in response to the clip. Empathic responses were operationalized as participants feeling the same emotion they identified the character to be feeling.

Results: Participants with TBI had lower emotion recognition scores (p=.007) and fewer empathic responses than HCs (67% vs. 79%; $p<.001$). Participants with TBI accurately identified and empathically responded to characters' emotions less frequently (65%) than HCs (78%). Participants with TBI had poorer recognition scores and fewer empathic responses to sad and fearful clips compared to HCs. Affect recognition was associated with empathic responses in both groups (p<.001). When participants with TBI accurately recognized characters' emotions, they had an empathic response 71% of the time, which was more than double their empathic responses for incorrectly identified emotions.

Conclusions: Participants with TBI were less likely to recognize and respond empathically to others' expressions of sadness and fear, which has implications for interpersonal interactions and

relationships. This is the first study in the TBI population to demonstrate a direct association between an affect stimulus and an empathic response.

Key Words: brain injury, emotion, emotional responses, affect recognition, empathy

The ability to accurately recognize and empathize with how others are feeling is fundamental to interpersonal interactions and social connectedness.[1-3] Affect recognition depends primarily on interpretation of nonverbal cues (e.g., facial or vocal expressions) [4] portrayed by others, while empathy involves elicitation of concern or a mutual feeling, or the ability to cognitively understand another's emotion.[5] It is widely acknowledged that affect recognition and empathy are frequently compromised following a TBI[3,6-11], negatively impacting psychosocial outcomes.

Affect recognition and empathy are generally believed to be related. While it is assumed that affect recognition is important for generating an empathic response,[3,10] it has been conversely postulated that empathy also facilitates affect recognition[12,13] through involuntarily mirroring of nonverbal cues [14-16] and perspective-taking. Despite the theories, there has been relatively weak to modest empirical support for the relationship between affect recognition and empathy in the non-TBI population[15,17-19] and even weaker evidence in the limited studies in TBI.[2,3,10] A study in participants who had TBI and healthy controls, found participants with TBI to have lower affect recognition and empathy than healthy controls; however, no significant association was found between these two variables.[3,10] Another study employed regression models to determine the amount of empathy variance that could be explained by affect recognition and alexithymia (emotional insight).[2] Part correlations were used to examine individual associations in the models. While vocal affect recognition was weakly correlated with cognitive empathy (-.207), no other substantial associations were noted.

The weak and/or insignificant associations between affect recognition and empathy in the aforementioned studies may be due to a design limitation. Neither study evaluated whether there was a direct correlation between participants' identification of an emotion expression

and their empathic response to that expression. Instead, both studies used questionnaires to measure participants' typical empathic tendencies, and then compared those responses to their performance on an unrelated affect recognition task.

Yirmiya and colleagues[20] evaluated a more direct relationship between affect recognition and empathy in children with autism spectrum disorder, using the Fleshbach and Powell Audiovisual Test for Empathy. [21] This test is comprised of video-recorded scenarios of children experiencing various events and emotions. Yirmiya and colleagues had participants report how they thought the character in the video was feeling (i.e., affect recognition) as well as how they felt in response to the scenario (i.e., empathic response). Thus, they used these stimuli to directly examine the association between affect recognition and empathy. A true empathic response was defined as "the participant felt the same emotion that he or she perceived the character to be feeling", regardless of whether that perception correctly matched the intended emotion of the test. Yirmiya et al. found that participants with autism had poorer affect recognition and fewer empathic responses than healthy controls. Moreover, they found a strong correlation between affect recognition and empathy ($r=.68$, $p<.01$)[20].

The aims of the current study were to examine empathic responses to affective film clips in participants with and without TBI; and to determine the association of empathic responses and affect recognition using a similar method to Yirmiya and colleagues.[20] Results of the current study should provide a clearer and more accurate understanding of the affect recognition-empathy relationship in the TBI population. Previous studies have indicated that people with TBI have low empathy and blunted emotional responses to affective stimuli[8,22,23], thus it was hypothesized that they would be less likely to report a shared emotional response with characters in film clips than healthy controls. However, based on Yirmiya et al.'s[24] findings, we

hypothesized an association between emotion recognition accuracy and empathic responses for both groups, building empirical support for this relationship in the TBI population.[12,25]

METHODS

Study Design

This was a multi-site cross-sectional study using a quasi-experimental design.

Participants

Participants were a convenience sample of people with and without TBI from North Carolina, USA and Ontario, Canada who participated in a broader study evaluating multiple aspects of emotional processing, which has resulted in other publications.[2,24] Recruitment letters and flyers were sent to former and current patients of outpatient brain injury rehabilitation facilities, group homes and local support groups. Healthy controls (HC) were recruited from the local community and universities, as well as through friends and family members of the participants with TBI. The research ethics committee for each site approved this study, and all participants provided informed consent prior to participation.

120 participants were enrolled in the study (TBI=60; HC=60). As a pilot study using novel affective film clips, power analyses were based on two studies in the TBI population: one examining affect recognition and another examining responsiveness to unpleasant emotional stimuli.[26,27] The analyses indicated that a sample size of 120 was sufficient to detect medium effect sizes, with 80% power, for independent sample *t*-tests and partial correlations using two tails. All participants with TBI met at least one of the Mayo classification criteria for moderate to severe TBI[28] (see Table 1). Participant race was predominantly Caucasian (87% TBI; 93% HC); the remainder of participants were African American. Both groups had completed similar years of education (TBI: mean=14.43; SD=2.29 and HC: mean=15.72; SD=1.96). Groups were

frequency matched for age and sex. Mean ages were 40.98 (SD=12.45) and 40.63 (SD=13.05) years old, respectively, for participants with TBI and HCs. The majority of participants were males (62% TBI; 63% HCs). Control participants were excluded for a TBI of any severity (including concussions leading to post-concussive syndrome). All participants were excluded for developmental affective disorder (e.g., autism spectrum disorder); acquired non-traumatic neurological disorder (e.g. stroke, anoxia); major psychiatric disorder (e.g., bipolar disorder; schizophrenia); or uncorrected vision and/or hearing deficits that would interfere with study participation (determined by interaction with participants during the prescreening process).

Measures

Affective Film Clips (measure of emotion recognition and empathic response)[29]*:* No standardized test for eliciting emotional responses in adults was available. Hence, we created our own using film clips found to effectively elicit a targeted emotional response in healthy college students (n=70).[35] Emotion recognition accuracy for these film clips was not tested in this group of college students.[29] For the current study, 15 film clips (45-103 seconds long) portraying happy, sad, angry, fearful, and neutral emotions (3 per emotion) were presented to participants. Emotions were primarily depicted through nonverbal cues (e.g., facial expressions); verbal dialogue provided context but no explicit mention of the target emotion. Clips were randomized into three orders; participant assignment was determined by a computerized random number generator. After each clip, participants were asked to select from a list of options, which emotion the main character was portraying, and what emotion best described how they themselves felt while watching the clip. Responses included the five emotional categories listed above as well as "I don't know". Total score ranges for emotion recognition accuracy and personal empathic responses are 0-15; scores for each emotional category ranged from 0-3.

Procedures

Participants completed a short demographic and medical history questionnaire. Eligible participants were randomized to one of the film clip orders and administered the Film clip assessment amongst other measures included in the broader study.

Data Analyses

Descriptive statistics were calculated for emotion recognition and empathic responses to characters' emotions in the film clips. Affect recognition group differences were calculated with two-tailed independent *t*-tests. Using our operational definition of empathy as having the same emotional feeling as what one perceives another to be feeling, responses to each stimulus item were categorized as empathic (1) or not empathic (0), and groups were compared for frequency of empathic responses using Chi-Square analyses.

To examine associations between affect recognition and empathic responses, responses for each individual film clip item were categorically coded and paired for an emotionally empathic response (1=empathic response, 0=no empathic response) and emotion recognition accuracy (1=correct, 2=incorrect) for each participant. Chi-Square analyses were conducted to examine the "paired item" associations of empathic response with emotion recognition accuracy for each participant group. Finally, the frequency in which participants both accurately recognized the emotion and responded empathically (i.e., dual occurrence) was calculated and Chi-Square analyses were used to determine group differences.

Significance was determined with α=.05 unless otherwise stated. Adjustments for multiple comparisons were not applied due to the preliminary nature of the study. SPSS Statistics Version 24 was used to conduct all analyses.

RESULTS

Associations with Demographics and Injury Related Variables

Groups did not significantly differ for age (t=.146, p=.884) or sex (χ^2=.036, p=.850). Although groups differed in years of education (t=-3.064, p=.003), education did not significantly correlate with emotion recognition (r=.060, p=.546) or mean number of empathic responses (r=.126, p=.199). In participants with TBI, PTA and LOC did not significantly correlate with emotion recognition accuracy (r=.022, p=.870; r=-.037, p=.780, respectively) or number of empathic responses (r=-.116, p=.384; r=.054, p=.684, respectively), nor did years post-injury (emotion recognition accuracy: r=.012, p=.925; mean number of empathic responses: r=.036, p=.784).

Emotion Recognition Accuracy to Film Clips

Since the Film Clip test was being used for the first time as an emotion perception test, recognition accuracy was explored first, and clips recognized by fewer than 80% of HCs were eliminated. To ensure emotion categories were properly represented, it was decided that each category had to have at least two valid stimuli to be included in analyses. All three happy and fearful film clip stimuli, and two of the sad film clips met the 80% criterion. Because only one angry film clip stimulus and no neutral stimuli met this criterion, they were excluded from the remainder of the analyses. Scores for the happy, fearful and two sad clips were summed for a total emotion recognition score. Scores for each of the three emotional categories were also tallied.

Participants with TBI had lower emotion recognition scores than HCs (t=-2.745, p=.007). Participants with TBI were worse at recognizing sad (t=-2.191, p=.031) and fearful (t=-2.776, p=.007) clips than HCs; no group differences were found for recognizing happy (t=.000, p=1.000).

Emotionally Empathic Responses to Film Clips and Group Differences

HCs had significantly more empathic responses (79%) than the TBI group (68%) (χ^2=14.332, p<.001). The frequency of empathic responses to happy characters was 78% for participants with TBI compared to 85% for HCs; this was not significantly different (χ^2=3.173, p=.075). However, the frequency of empathic responses to sad characters was significantly lower for participants with TBI (67%) compared to HCs (83%), χ^2=7.935, p=.005, as was empathic responses to fearful characters: TBI =58%; HCs=69%, χ^2=4.785, p=.029. See Figure 1.

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Association of Emotionally Empathic Responses with Emotion Recognition Accuracy

For both participant groups, emotion recognition accuracy and empathic responses for each film clip were significantly related (TBI: χ^2=26.572, p<.001; HCs: χ^2=38.777, p<.001). When emotions in the film clip were accurately identified, participants with TBI had an empathic response 71% of the time, and HCs 81% of the time. Conversely, when the emotion was not identified correctly, the frequency of empathic responses by participants with TBI reduced to 32% and HCs to 18%. When participants had an emotionally empathic response to the character in the film clip, recognition for that character's emotion was correct 96% of the time for participants with TBI and 99% of the time for HCs. When emotionally empathic responses did not occur, this recognition accuracy reduced to 82% for participants with TBI and 86% for HCs.

Dual Occurrence of Both Accurate Affect Recognition and Empathic Responses

The frequency for which participants had both accurate recognition of the character's emotion and an empathic response to that stimulus (e.g., correctly identified the character as sad and felt sad) was compared between groups. HCs accurately recognized and empathically responded to a character's emotion more often than participants with TBI (78% vs 65%,

respectively; χ^2=19.633, p<.001). HCs had greater accuracy and empathic responses to sad (83% vs 64%, χ^2=10.313, p=.001) and fearful (68% vs 53%, χ^2=7.861, p=.005) emotions in films than TBI. There was no group difference for happy (85% vs 77%, χ^2=3.554, p=.059). See Figure 2.

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DISCUSSION

The purpose of the current study was to examine empathic responses to emotional stimuli in people with and without TBI, and to determine the relationship between emotion recognition and empathic responses. Although many studies have illustrated impaired affect recognition and reduced empathy after TBI[2,6,11,30], the association between these has not been well explored or supported.[3,10] The current study was novel in that it was the first of its kind to explore this association for people with TBI, evaluating both affect recognition and emotional empathy responsiveness within a single set of dynamic stimuli.

There are several main takeaways from this study. Compared to HCs, participants with TBI had lower affect recognition scores and fewer emotionally empathic responses to the characters' emotions in the film clips, particularly for sad and fearful expressions. As hypothesized, affect recognition and empathic responses were significantly associated with one another in both participant groups. This suggests that although affect recognition accuracy and empathy are reduced after TBI, the relationship between these variables is still present after a neurological insult. Shamay-Tsoory et al[3,10] and Neumann and colleagues[2] also found reduced affect recognition and empathy after TBI, but did not find a significant association between the two in the TBI population. This discrepancy is likely due to the different approach used in the current study, which directly connected recognition of affective stimuli with empathic responses to those stimuli.

This study also showed that when participants with TBI correctly identified the characters' emotions, they were more than twice as likely to respond empathically than if they misidentified the emotion (71% versus 32%). However, accurate recognition of emotion did not always equate to an empathic response (i.e., they still failed to respond emphatically 21% of the time). This was also true for HCs who responded empathically 81% of the time after correctly identifying the characters' emotions. Overall, these results indicate that emotion recognition training for people with TBI should not necessarily be expected to translate to an empathic response. Thus, it is important that empathy also be directly targeted. Some existing interventions have participants mimic facial expressions of the characters they are identifying to elicit a shared emotional response.[31-33] While it is uncertain if an "empathic response" is achieved, interventions using this method have successfully improved affect recognition in people with TBI. Another study suggests that perspective taking can be trained to improve cognitive empathy, and perhaps trigger an empathic behavior (e.g., console a sad friend).[34]

It appears that one can still accurately recognize others' emotions without having an empathic response. For instance, we found that even when an empathic response was absent, identification of characters' emotions remained relatively high for participants with (82%) and without (86%) TBI. Since a shared emotional experience is not necessary for accurate affect recognition, emotion identification may be occurring through other means, such as attention to and interpretation of visual cues (e.g., characteristics of eyebrows).[13,30] That said, we also found that when there was an empathic response, participants almost always recognized the character's expression (>95% for both groups). Due to the high affect recognition rates in the presence of empathy, interventions should consider empathy training (e.g. mimicry or perspective-taking).

Since socially appropriate responses require both accurate affect recognition and an empathic response, we examined the simultaneous occurrence. Participants with TBI correctly identified *and* empathically responded to the characters' emotions (e.g., correctly identified character as sad and also felt sad) 65% of the time. Given that the literature reports reduced affect recognition and empathy after TBI,[3,8-11], this proportion of dual occurrence was somewhat higher than expected. However, it was still significantly less than HCs who showed dual occurrence 78% of the time. The primary difference was in response to sad and fearful stimuli. A decreased ability to recognize and empathically respond to sad and fearful emotions has important implications for interpersonal interactions and relationships since emotional support is particularly important during these vulnerable emotional experiences. Our results suggest that people with TBI are unlikely to adjust their behavior and/or provide appropriate emotional support when these emotions are expressed by others.

Limitations

The direction of the association between affect recognition and empathy cannot be determined from the design of the current study. It remains unknown if affect recognition is influencing empathy or vice versa, or if both influence one another. Future research should attempt to elucidate the nature of this relationship. Further, this study is limited by a lack of physiological data, which could have provided us with a more comprehensive picture of participants' subjective emotional responses to the film clips. Additionally, there may have been some perseveration or social desirability bias that led participants to report experiencing the same emotion they identified the characters to be feeling. However, if this was the case, participants' emotion recognition responses would have always matched their emphatic ones, but they did not (68% and 79% for TBI and HC, respectively). To account for this potential

confound, future studies should consider administering a social desirability questionnaire. Finally, visual and auditory functioning were not formally tested in this study so there is a possibility that more subtle impairments may have influenced emotion perception. Future studies may want to consider adding formal assessments of these functions.

CONCLUSIONS

Findings from this study suggest that people with TBI have empathic responses to emotional stimuli, but these responses are less common compared to healthy controls. This is particularly evident for sad and fearful expressions, which may impact interpersonal relationships. Additionally, this study found a robust association between affect recognition and empathy. This finding contrasts previous studies where the association was either weak or not supported. Empathic responses were more than twice as likely to occur when emotion recognition was accurate; however, it was also apparent that affect recognition on its own did not guarantee an empathic response. Future research should explore the direction of the association between affect recognition and empathy, and whether shared emotional experiences can be enhanced after a TBI with treatment.

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Table 1. Injury characteristics of TBI sample.

Injury Characteristics	n	Mean (SD)	Range
Time Since Injury (Years)	**60**	13.68(10.53)	.5-37
Mayo Classification			
Glasgow Coma Score	17	4.47 (2.48)	3-12
Post-Traumatic Amnesia	31	19.9 (38.16)	.5-180
Loss of Consciousness	40	43.05 (50.66)	.5-180
Cause of Injury	**60**		
Motor Vehicle Accident	43		
Falls	9		
Other	8		

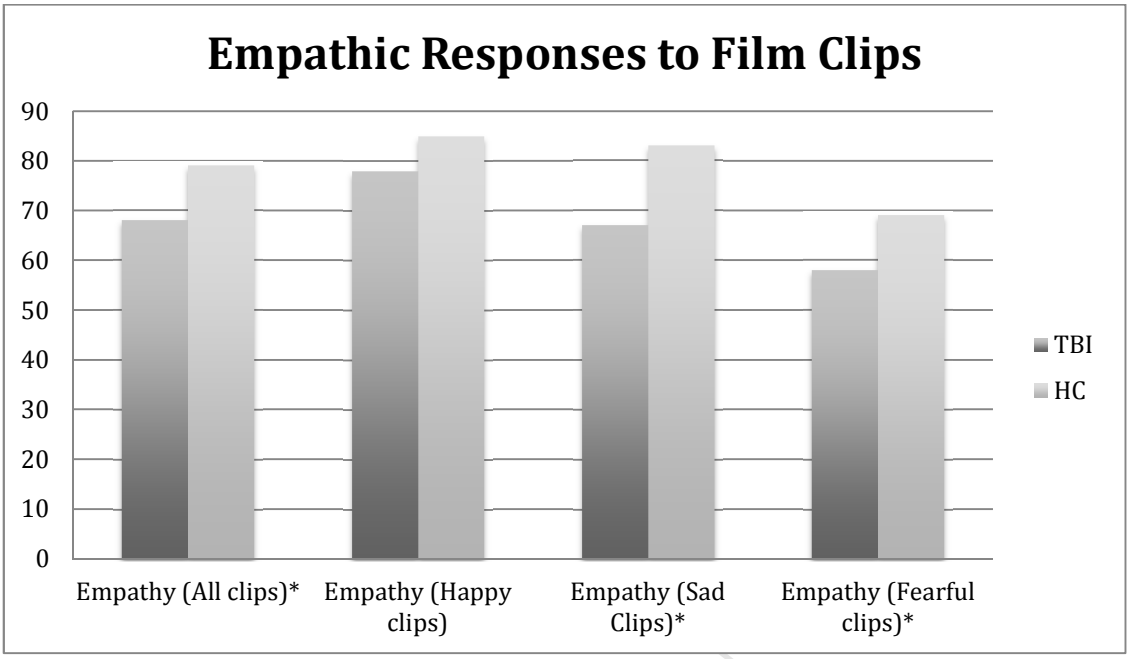

Figure 1. Percent of occurrences that participants empathically responded to the emotion expressed by characters in the film clips (i.e., felt the same emotion as they perceived the character to be feeling)

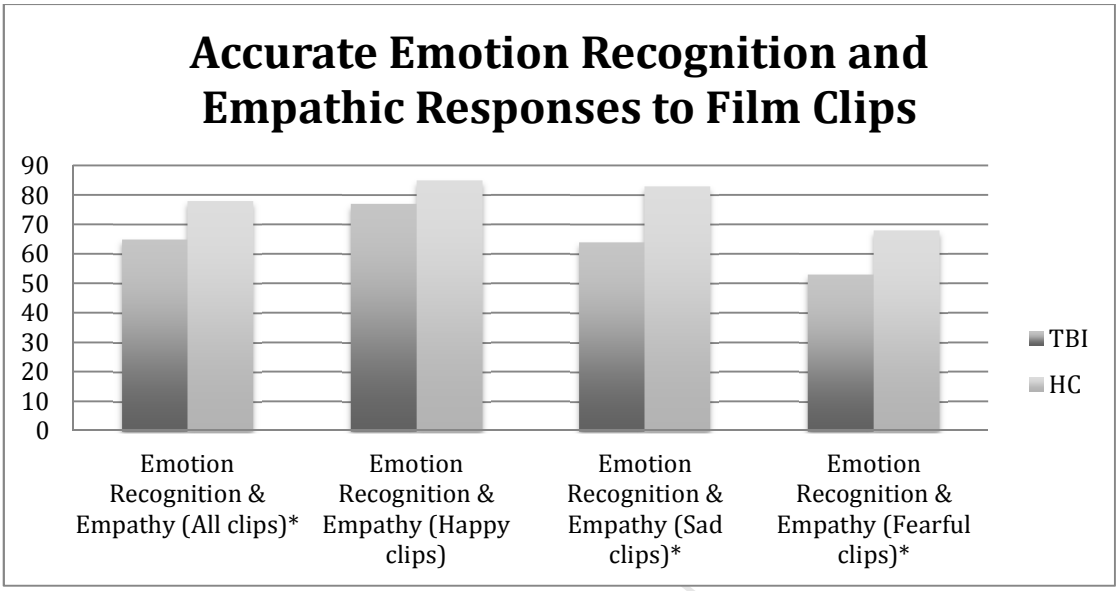

Figure 2. Percent of occurrences that participants both accurately recognized emotions expressed by characters in the film clips and also empathically responded to the emotion (i.e., felt the same emotion as they perceived the character to be feeling)