Emotion Recognition and Traumatic Brain Injury

by

Cassie Anne Brown

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Graduate Supervisory Committee:

Heather Harris Wright, Chair
Denise Stats-Caldwell
Kelly Ingram

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ABSTRACT

Emotion recognition through facial expression plays a critical role in communication. Review of studies investigating individuals with traumatic brain injury (TBI) and emotion recognition indicates significantly poorer performance compared to controls. The purpose of the study was to determine the effects of different media presentation on emotion recognition in individuals with TBI, and if results differ depending on severity of TBI. Adults with and without TBI participated in the study and were assessed using the *The Awareness of Social Inferences Test: Emotion Evaluation Test* (TASIT:EET) and the *Facial Expressions of Emotion-Stimuli and Tests* (FEEST) *The Ekman 60 Faces Test* (E-60-FT). Results indicated that individuals with TBI perform significantly more poorly on emotion recognition tasks compared to age and education matched controls. Additionally, emotion recognition abilities greatly differ between mild and severe TBI groups, and TBI participants performed better with the static presentation compared to dynamic presentation.

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Chapter 1: Introduction

Traumatic Brain Injury

Traumatic brain injury (TBI) is an acquired neurogenic disorder that can significantly impact an individual both medically and psychosocially (Brookshire, 2007). Approximately 1.7 million Americans sustain a TBI each year, which contributes to an estimated one-third of yearly injury-related deaths (Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, 2010). A TBI is a direct result of external forces abruptly applied to the skull and brain which cause either a penetrating (open) or non-penetrating (closed) head injury (Brookshire, 2007). Penetrating head injuries indicate that the skull has been fractured or the meninges have been compromised. Non-penetrating head injuries indicate an intact skull and meninges. According to the Centers for Disease Control and Prevention (CDC, 2010), motor vehicle accidents are the most common cause of TBI. Several risk factors may place an individual at a higher risk for TBI including: school adjustment/social history; socioeconomic status; a history of TBI; participation in high risk sports; and *Type A* personality. TBI also disproportionately affects a greater amount of males than females, especially in young adults (Brookshire, 2007).

Different methods may be used to act as prognostic indicators for individuals with TBI. The most reliable measure for determining the severity of a TBI is the duration of altered state of consciousness (Brookshire, 2007). One method, the *Glasgow Coma Scale* (GCS; Jennett & Teasdale, 1981), provides uniformity for the measurement of different levels of consciousness through observations and ratings of eye opening, motor responses, and verbal responses from the patient (Jennett & Teasdale, 1981). Another valuable measure of consciousness is the *Comprehensive Level of Consciousness Scale* (CLOCS; Stanczak & associates, 1984), which assesses a broad range of responses including body posture, resting eye position, spontaneous eye opening, eye movements, papillary reflexes, motor functioning, responsiveness, and communicative effort (Stanczak et al., 1984). An effective indirect indicator for severity of TBI is the duration of post traumatic amnesia (PTA), which is the amount of time following a coma that the individual is incapable of storing new information and experiences in memory (Kennedy & Trzepacz, 2005). The Galveston Orientation and Amnesia Test (GOAT; Levin, O'Connell, & Grossman, 1979) is an assessment measure that can be administered repeatedly to determine the status of PTA. Performance on the GCS at time of injury, as well as PTA duration, are used to estimate the severity of the head injury. Severe TBI is represented by a GCS score of 3 to 8 and PTA duration greater than seven days, moderate TBI scores range from 9 to 12 and PTA duration between one and seven days, and 13 to 15 with PTA duration less than 24 hours to indicate a mild TBI (Kennedy & Trzepacz, 2005). The pattern of recovery for individuals with TBI predictably follows the stages sequenced in the Ranchos Los Amigos Scale of Cognitive Levels; a scale of cognitive recovery which includes 10 levels of functioning (RLA; Hagen, 1997). Individuals suffering from a severe TBI typically progress from unresponsive to responsive, agitated to non-agitated, confused to oriented, inappropriate to appropriate, and lastly, from automatic to purposeful (Brookshire, 2007). It is important to specify that although this pattern displays how many individuals with TBI may progress, not all individuals begin in the unresponsive state and additionally not all individuals reach an appropriate, purposeful state. Common behavior and cognitive characteristics following TBI observed by researchers include attention deficits, memory impairments, agitation, deficits with inhibition of inappropriate behaviors, and executive functioning deficits (McDonald, 2005). Additionally, individuals with TBI commonly experience problems with pragmatics and language. Characterized by their inability to make inferences, individuals with TBI often struggle with language that is abstract and generally reflect the ability to only understand concrete or “black and white” thinking (McDonald, 2005). Individuals with TBI may struggle with sarcasm, hints (i.e. inferences), diplomatic lies, and indistinct advertising slogans in which they would be required to draw from cues to fully understand the underlying message (McDonald, 2005). Deficits shown with inferences and abstract language directly coincide to the individual’s problematic pragmatic functioning.

Emotion Recognition

Individuals who have sustained severe TBI often experience problems with cognition, behavior, and linguistic skills, which are all necessary to effectively and efficiently communicate as well as functionally participate in a social setting (Watts & Douglas, 2006). These individuals also commonly report problems with social situations and feelings of isolation due to their inability to interpret emotions from facial expressions (i.e. nonverbal cues) (Knox & Douglas, 2009). Emotion recognition through facial expression is believed to play a crucial role in communication competence (McDonald, 2000; Watts & Douglas, 2006; Knox & Douglas, 2009). It allows the speaker to convey emotions and make inferences without the need for excess verbiage.

Emotions are recognized and interpreted by visualizing a speaker's expressions (i.e. such as smiling, furrowed brow, or widened eyes) and processing their importance in different areas of the brain (Sprengelmeyer, Rausch, Eysel, & Przuntek, 1998). Researchers continue to debate the specific location of where emotions are processed in the brain; however, some researchers hypothesize that emotions may be recognized based on separate or partially separable neural structures (Sprengelmeyer, Rausch, Eysel & Przuntek, 1998; Adolfs et al., 1994; Calder et al., 1996; Sprengelmeyer et al., 1996, 1997b). Damage to these neural structures in the brain may result in deficits in emotion recognition. Deficits in emotion recognition can lead to significantly impaired social functioning (Douglas & Spellacy, 2000; Elsass & Kinsella, 1987; Hammond, Hart, Bushnik, Corrigan, & Sasser, 2004; Ponsford, Olver, & Curran, 1995).

In recent studies, researchers have focused their attention on six emotions that have been deemed basic and universally understood. They include: happiness, sadness, anger, anxiety/fear, surprise, and disgust. Researchers have suggested that participants with TBI have more difficulty recognizing and interpreting negative emotions compared to positive emotions (Croker & McDonald, 2005; Williams & Wood, 2009). Williams and Wood (2009) believe that TBI participants may experience greater difficulty recognizing negative emotions compared to positive emotions because negative emotions have an increased number of shared cues (e.g. a furrowed brow is shared by both anger and sadness). Deficits in interpretation of nonverbal cues from the speaker can decrease efficiency of understanding emotions conveyed and subsequently hinder social integration.

Statement of the Problem

It is well documented in the literature that individuals who suffer from TBI present with deficits with emotion recognition that can significantly impact social functioning; however questions still remain regarding the nature of the deficit and how it relates to TBI as a spectrum of severity. The growing body of literature that offers insight to emotion recognition in TBI included only participants who have sustained severe TBI (Watts & Douglas, 2006; Croker & McDonald, 2005; Bornhofen & McDonald, 2008; Knox & Douglas, 2009). Individuals who suffer from TBI have a vast range of severities and repercussions, and the mild to moderate TBI range repeatedly remain unrecognized when discussing these deficits. Although the deficits may not be as easily identifiable as in individuals with severe TBI, the impact remains the same. For example, an individual with a mild TBI may have the capacity to attend college, but is unable to decipher a simple inference from a professor. By identifying deficits associated with the severity of TBI sustained, researchers, speech-language pathologists, and neuropsychologists will have a better understanding of their cognitive abilities for both future research and therapeutic intervention.

A popular aim in current TBI research, regarding emotion recognition and interpretation of facial cues, is determining the most sensitive method of assessment. Many researchers have used static assessments (i.e. photographs) to try and limit helpful contextual cues and focus on facial features alone; however, the functionality of a static measure is limited. Participants are able to focus on facial features, but generalization to real life social situations is not represented. In addition, studies focusing on media presentation revealed mixed results as to whether a dynamic display (i.e. video vignettes) was facilitative or added an increased level of difficulty. In order to better understand social functioning for individuals with TBI and plan for possible intervention strategies, assessments should be administered in a method that is more representative of daily experiences.

The purpose of this study was to build on the previous research investigating emotion recognition and the ability to interpret nonverbal facial cues. Additionally, this study examined a range of severities from mild to severe. The aims of the study were as follows:

1. To determine if participants with TBI differ in emotion recognition tasks compared to age-matched, control participants.
2. To determine if emotion recognition ability using nonverbal cues only differs depending on severity of TBI.

3. To determine if participants with TBI differ on emotion recognition tasks that include contextual cues (i.e. dynamic) compared to emotion recognition tasks that include only nonverbal cues (i.e. static).

Chapter 2: Review of Literature

Knox and Douglas (2009) investigated the relationship between social integration and the ability to recognize facial expression in individuals with traumatic brain injury (TBI). Participant groups included a TBI group and a control group. Inclusion criteria for the TBI group consisted of individuals who sustained a severe TBI, defined by a Glasgow Coma Scale (GCS;Jennett & Teasdale, 1981) score of 8 or less and/or a post traumatic amnesia (PTA; Marosszeky, Ryan, Shores, Batchelor & Marosszeky, 1997) of 14 days or more, within the past 2 to 8 years and have the ability to provide informed consent. Participants in the control group were matched to the TBI participants by age, education, and gender. All participants met the following inclusion criteria: completion of their education in English, passing a visual perception task, and passing a literacy screening task. Participants were excluded from the study if they had a history of psychiatric illness, drug or alcohol abuse, or any existing neurological condition.

Two measures were adapted for this study to determine ability to interpret emotions. One measure included a dynamic presentation of the stimuli via video; the other measure included a static presentation of the stimuli via photographs. The dynamic presentation involved actors portraying different emotions in short scenarios and the static presentation included the different emotions presented by individuals in photographs. The emotions that were included across measures included sadness, happiness, anger, surprise, anxiety [fear], and disgust. For the dynamic measure, the participants were required to recognize basic emotions developed from subtests of *The Awareness of Social Inference Test* (TASIT; McDonald, Flanagan, & Rollins, 2002). In this task, scenes of actors displaying three examples of each of six different emotional states were shown. The participants pointed to one of the six emotions from a multiple choice arrangement that best described the emotion from the scene. For the static measure, Knox and Douglas (2009) used the *Facial Expressions of Emotion* recognition task from the *Japanese and Caucasian Expressions of Emotion* (JACFEE; Matsumoto & Ekman, 2004) as well as an adapted version of the *Contextual Test of Emotion* (CTE; Braun et al., 1989). These tasks targeted the ability to identify emotions in an isolated situation (individual displaying an emotion) and social situation (how an individual might feel in a particular social situation). Additionally, all participants' current level of social integration and the ability to effectively communicate in their everyday surroundings was measured using the *Revised Craig Handicap Assessment and Reporting Technique* (R-CHART; Mellick, Walker, Brooks, & Whiteneck, 1999).

Results of the study indicated a significant group main effect for interpretation of facial expression; the TBI group performed significantly worse than the control group for interpreting facial expression regardless of display type. The TBI group was significantly less accurate with the dynamic presentation compared to the static presentation. A significant group main effect was also found for interpretation of emotional situations; the control group performed significantly better on the task compared to the TBI group. A relationship was found among the facial expression measures and social integration scores for the

TBI group. An additional relationship was found between the situation-emotion matching tasks for the TBI group and social integration scores. Knox and Douglas interpreted these results to indicate that TBI participants' abilities to effectively communicate in their everyday surroundings is closely tied to their success in interpreting facial expressions and understanding non-verbal cues in a social context.

Green, Turner, and Thompson (2003) examined the function of facial emotion perception in individuals with recently acquired TBI to observe the brain before functional reorganization has taken place. Green et al. hypothesized that damage to white matter tracts is responsible for the inability to perceive emotion. Inclusion criteria for the TBI group included a diagnosis of TBI characterized by positive computed tomography (CT) neuroimaging studies and/or a GCS of 12 or less. Exclusion criteria included: any presence of neurological disease or neuroradiological evidence of a previous brain injury, TBI that is secondary to another insult or stroke, non-fluent in English, participation in alcohol or substance abuse within 2 months of study participation, or psychotic illness. The mean age of study participants was 40.4 (SD= 14.8) with 24 males and 6 females. The mean GCS score was 7.41 (SD= 3.7) and the mean number of months post-injury was 2.6 months (SD= 1.3).

To test their hypothesis, Green et al. (2003) divided the TBI group into two subgroups; one group included participants with damage to the regions of the brain associated with perception of emotions (i.e. right posterior hemisphere, basal ganglia, and amygdala; here on referred to as +RPF) and the other group included participants with no evidence of focal insult to these respective areas (here on referred to as -RPF). A control group, matched by age to the TBI participants was also included. They met the following exclusion criteria: no active psychotic illness, neurological disease or a previous history of brain injury that required hospitalization. The control group and TBI group did not differ significantly for age but did for years of education completed; this group difference was controlled statistically during subsequent analysis.

The experimental measures included tasks from *The Florida Affect Battery - Revised* (FAB-R; Bowers et al., 1989; Bowers et al., 1998). The tasks included Neutral Face Discrimination, Emotional Face Labeling, and Emotional Face Discrimination. Green et al. hypothesized that the prefrontal lobe does not play a role in conceptual emotional perception tasks, but does play a role in lexical emotional perception tasks. Conceptual emotional labeling tasks refer to tasks in which minimal amount of lexical demands are present; such as, sorting or discrimination. Lexical emotional labeling tasks refer to tasks that involve explicit verbal requirements; such as, labeling. Examining deficits in perception and/or conceptual facial emotion perception tasks allows researchers to discern if diffuse axonal injury (DAI) is implicated. Green et al. hypothesized that the TBI subgroup involving no focal lesions would demonstrate poorer performance on the conceptual emotional perception tasks indicating impaired emotional perception is due to DAI.

During the Neutral Face Discrimination task participants viewed pairs of photographs containing two female faces representing the same woman or two faces representing different people. The participants indicated if the photographs represented the same person or different people. On the Emotional Face Labeling task, participants viewed photographs of different women, each displaying one of five different emotions (happiness, sadness, anger, fear or neutral). The participants identified the emotion represented in each photograph. The Emotional Face Discrimination task, included photographs that contained two different female faces displaying either the same or different emotions. The participants indicated if the emotions displayed were the same or different.

Results included significant main effects for group and task, as well as a significant group by task interaction (with both TBI subgroups combined). The TBI subgroups performed similarly to the control group on the neutral face discrimination task, but both performed significantly more poorly than the control group on the Emotional Face Discrimination and Emotional Face Labeling tasks. When comparing the performance across the three tasks by all three groups (+RPF subgroup, -RPF subgroup, control group), a significant main effect of group, task, and group by task interaction was found. The TBI subgroups performed similarly, whereas the control group performed significantly better on the two emotion discrimination tasks. No significant differences were found between the two TBI groups for any of the tasks. Green et al. concluded that the TBI participants' emotion perception deficits were a result of DAI and not due to focal damage.

Watts and Douglas (2006) investigated the role of facial expression in communication competence for individuals following a TBI. They focused on whether processing and understanding facial expressions contributed to functional communication ability. Participants included individuals with and without TBI. The two groups were matched for age, gender, education, and occupation. Inclusion criteria for the TBI group included having sustained a severe brain injury as indicated by post-traumatic amnesia (PTA) duration of 7 days or greater. Participants were excluded from the study if they exhibited a prior history of neurological or psychiatric disorder other than TBI. All participants were required to have adequate cognitive function, English language skills to complete the study tasks, and sufficient hearing and vision acuity to perform the tasks. Each participant in the TBI group displayed neurological deficits consistent with diffuse axonal injury caused from motor vehicle accidents. An additional group of participants included an individual (i.e. partner, father, mother, child or friend) identified by the participants with TBI with whom they had weekly contact to determine perceived communication competence.

Two measures were included to test participants' perceived communication competence and ability to interpret facial expression. The communication measure was the *La Trobe Communication Questionnaire* (LCQ; Douglas et al., 2000) which required the participants to answer questions in an interview format with a clinician regarding their personal perceived communication abilities. The participants' "close-others" completed the questionnaire in a similar interview format or in a written form. The facial expression measure was the *Emotion Evaluation Test* (EET) adapted from *The Awareness of Social Inference Test* (TASIT; McDonald, Flanagan, & Rollins, 2002). The EET included two tasks (EET naming and EET recognition) to assess facial expression.

The LCQ measured the individuals' discourse for interpersonal communication skills in addition to communication competence in circumstances that involve recognition of facial expression. For the EET naming task, participants viewed videos of actors displaying one of six different emotions (happiness, sadness, anger, surprise, disgust/revulsion, or anxiety/fear) then asked to identify the emotion displayed. The responses were not limited by time; however, the participants viewed each video one time only. For the EET recognition task, participants viewed videos of actors displaying different emotions and identified the emotion from a multiple choice array. Six different emotions were printed in large bold font on a piece of paper situated in front of the participant. The clinician instructed each participant that only one choice may be selected. As with the first EET task, there was no time limit for responding but only one viewing of each video was permitted.

Each EET task consisted of 18 scenes. Sound was omitted to eliminate any cues that may be provided by pitch, quality, volume, and speech content. The examiners instructed participants to focus on the facial expression of the actor. Each video scene was approximately 15-60 seconds in length and depicted individuals in everyday situations.

Results indicated a significant group effect for responses on the LCQ; the TBI group had significantly higher scores than the control group indicating greater perceived difficulty with communication. A significant group effect was also found for performance on the EET naming and recognition tasks. The TBI group performed significantly worse than the control group for both tasks. No significant task effect was found; that is, groups performed similarly across the naming and recognition tasks. Study results also indicated a significant relationship between performance on facial expression tasks for the TBI participants and the LCQ "close-other" measure; however no significant relationship was found between performance on the facial expression tasks and the self-reported LCQ. The relationship between TBI performance and the LCQ "close-other" measure indicated that deficits in the facial expression tasks coincide with deficits in everyday functional communication competence perceived by individuals with a close association to the TBI participants. Results from this study further reaffirm previous research findings demonstrating that communication difficulties are related to deficits in understanding facial expression.

Croker and McDonald (2005) investigated the ability of individuals with TBI to recognize emotions in both labeling and matching tasks to assess performance of perceptual recognition of emotion, semantic knowledge of emotions in social situations given only contextual cues, and perceptual recognition of facial expression given contextual cues. Participant groups included a TBI group and a control group. Inclusion criteria for the TBI group consisted of individuals who sustained a TBI, defined by PTA duration of 24 hours or greater, and demonstrated no known sensory deficits, aphasia, agnosia, psychosis, immediate memory difficulties, or prosopagnosia. The 24 participants in the study included 17 males and 7 females with a mean age of 37.9 years (SD=12.6). The mean post-injury time period was 8 years with an average PTA duration of 83 days, placing each participant in the severe range. Site of brain damage included right hemisphere (N = 6), left hemisphere (N = 5), bilateral (N = 10), and unknown (N = 4). A control group of 15 individuals matched for age, sex, education, and occupation were also included. Not surprisingly, the TBI group had a greater unemployment rate compared to the control group.

To measure emotional recognition abilities, the researchers used one task assessing visual discrimination and face perception and four tasks assessing emotion recognition. The emotions displayed across measures included happiness, surprise, anger, sadness, fear, and disgust. The four emotion recognition tasks included two tasks to assess perceptual recognition of emotions, labeling and matching, using photographs and printed labels. In the labeling task, participants were instructed to match a photograph of a facial expression to a printed label. The matching task bypassed the need for printed labels and instructed participants to match photographs displaying the same emotion from an array of four alternative photographs underneath the target. In the third task, semantic knowledge of emotions, researchers presented scenarios verbally and instructed the participant to identify how an individual would feel in a particular situation given the contextual information. The final task, perceptual recognition of facial expression given contextual cues, included scenarios and photographs; participants were instructed to match a facial expression that was appropriate for the subject of the story given the contextual information. After choosing the appropriate facial expression, the participants were asked to select a label for it from a list of seven choices. Both perceptual recognition tasks were context-free and differed in stimulus material to reduce any carry-over effects. To measure face recognition and visual discrimination, a shortened version of the *Benton Facial Recognition Test* (BFRT; Benton, Hamsher, Varney, & Spreen, 1983) was administered. Participants identified a specific individual from an array of six photographs. The task increased in difficulty by alternating the view of the photographed individual from a full anterior view to three-quarter views or anterior views with differences in lighting. All four emotion recognition tasks included photographs extracted from the *Pictures of Facial Affect* series (Eckman & Freisen, 1976). Once all tasks were administered, the examiner interviewed each participant (excluding the control group) about their perceptions of the six emotions in everyday life and differences they have experienced pre- and post-onset of the TBI.

Results indicated that the TBI group performed more poorly on all tasks compared to the control group. Both groups performed at or near ceiling level on the semantic knowledge of emotions task; however, the TBI group was unable to match the appropriate emotion and context. The TBI participants relied heavily on contextual cues; rather than facial expressions. In contrast, a few number of TBI participants displayed contrary patterns by showing increased difficulty with contextual cues, thus suggesting more severe deficits in facial recognition. For both groups, labeling accuracy improved for emotion recognition when presented with contextual cues relative to no contextual cues. The TBI group also demonstrated more success with recognizing positive emotions (i.e. happiness and surprise) in comparison to negative (i.e. sadness, anger, fear, and disgust). In addition, self reported emotional changes and performance accuracy for the TBI group indicated that individuals expressed a mild to moderate change in perceived experience with emotions following their TBI. The majority of TBI participants reported a general increase in experiencing sadness and decrease in experiencing happiness. Croker and McDonald (2005) hypothesized that poor matching may be connected to the participants' reduced subjective experiences of emotion (i.e., everyday emotional deficits); whereas, labeling has limited reliance on everyday experiences.

Williams and Wood (2009) examined whether performance differed in emotion recognition according to the media of presentation and the affective valence. Participant groups included a TBI group and a control group. Inclusion criteria for the TBI groups consisted of individuals who sustained a moderate to severe TBI (GCS < 12, PTA > 24 hours). Participants in the control group were matched to the TBI participants for age, gender, years of education and employment status. Participants were excluded from the study if they were unable to provide informed consent. Additional exclusion criteria for both the TBI and control groups included: pre-accident history of psychiatric and/or personality disorder, previous head injury or neurological disorder, developmental or learning disability, estimated pre-accident IQ of <70, dysphagia, and below the age of 20.

Participants were assessed using *The Awareness of Social Inference Test* (TASIT), *Part 1- The Emotion Evaluation Test* (EET; McDonald, Flanagan, &

Rollins, 2002), *Facial Expressions of Emotion-Stimuli and Tests* (FEEST): *The Ekman 60 Faces Test* (E-60-FT; Young, Perrett, Calder, Sprengelmeyer & Ekman, 2002), and neuropsychological measures to assess information processing speed and verbal ability. The first measure, TASIT-EET, assessed the participants' ability to recognize emotions portrayed by actors in 28 videoed scenes. Six basic emotions were depicted in the videos including: happy, surprised, angry, sad, fear, and disgust. Each participant was instructed to choose from five possible response cards containing four basic emotions plus (three foil cards) and a neutral response. The second measure, FEEST:E-60-FT, is a computer-run program that displays faces on the screen for 5 second increments followed by a blank screen during which time the participant is asked to determine the correct emotion. Participants were given options on the screen and unlimited time when determining the emotion depicted. Practice items were given for each emotion prior to assessment. To assess information processing speed, Williams and Wood employed the digital symbol and symbol search sections of the *Wechsler Adult Intelligence Scale 3rd Edition* (WAIS-III; Wechsler, 1997) and the *Trail Making Test* (TMT) *Parts A and B* (Lezak, 1995). To assess verbal ability, Williams and Wood administered the vocabulary and similarities sections of the WAIS-III.

Emotion recognition and confounding variables were examined first. For the TBI group, no significant differences were found for gender across all measures and individual emotions, years of education, National Adult Reading Test (NART), time since injury, and age at injury. The TBI group revealed a significant relationship between PTA and EET total scores, but when examined further (the TBI group was divided into respective moderate and severe classification groups) no significant PTA group differences for EET total scores were found. Results for the control group indicate no significant gender differences or relationship among years of education with performance on the measures and individuals emotions. Performance accuracy for different emotions for the EET revealed significant findings for a main effect of valence with both groups had greater accuracy in identifying positive emotions compared to negative emotions. A significant group by valence interaction was also found; a greater difference between recognition accuracy for negative and positive emotions was found for the TBI group compared to the control group. Performance accuracy for the E-60-ET revealed a significant main effect of group indicating that the TBI group performed more poorly at recognizing both positive and negative emotions compared to the control group. A significant main effect of valence was found indicating both groups had a higher accuracy level in recognizing positive emotions compared to negative emotions; the difference was greater for the TBI group. When examined further, the TBI group performed no worse than the control group for all positive emotions and sadness, however they performed significantly worse on the remaining three negative emotions (angry, fear, disgust).

Results for different media presentation revealed a significant effect of group, indicating the TBI group performed significantly worse on both types of media compared to the control group. A significant main effect for media presentation revealed that both groups performed better at recognizing emotions with the audiovisual display than the static display. Additionally, a significant main effect of emotion expression indicated that some emotions were more accurately recognized than others; this effect was greater with the TBI group. A significant interaction was also found between emotion expression and media. Both groups recognized each individual emotion more accurately when presented with the static display. When examined further, a significant difference for four emotions (happy, sad, angry, disgust) was found for the TBI group across the two media types. The TBI group performed more accurately on these four emotions with the audiovisual display. The control group also revealed significant differences for four emotions (surprise, sad, angry, disgust) across the two media types indicating a better performance with the audiovisual display. No significant correlations were found between the EET, the E-60-ET, and all four tests that examined information processing speed. Additionally, no significant correlations were found between the EET, the E-60-ET, and the two tests of verbal ability. Based on these findings, Williams and Wood (2009) concluded that although overall performance was better with the dynamic display, emotional valence greatly impacts participant performance.

Summary

As the body of research continues to grow investigating deficits in emotion recognition and TBI, limitations within these studies still exist. Small sample size remains as a primary limitation within much of the current research in this area (e.g., Knox & Douglas, 2009 N = 26; Croker & McDonald, 2005 N= 39;

Watts & Douglas, 2006 N= 24; Milders, Fuchs, & Crawford, 2003 N=34; Spell & Frank, 2000 N=48). By increasing the number of participants through this study, greater validation of any significant results will ensue. Another limitation addressed in this study was the issue amid participant criteria and selection. Past research disregarded the importance of understanding consequences in pragmatics (specifically emotion recognition) faced by the mild to moderate TBI severity range by only including participants with severe TBI (Croker & McDonald, 2005; Knox & Douglas, 2009; Watts & Douglas, 2006) . Williams and Wood (2009) included individuals with moderate to severe TBI, but only selected participants based on referral from experiencing difficulties in daily life. Identifying deficits based on a severity spectrum may reveal facilitative information for possible therapeutic intervention. Additionally, this study examined the issue of mixed results regarding media presentation to determine the effects of static vs. dynamic presentation of stimuli on communication. It is evident that a difference in media presentation influences emotion recognition following TBI; however, researchers had yet to provide concise information on whether contextual cues presented in a dynamic display are facilitative or impeding to ones' success in communication (Knox & Douglas, 2009; McDonald & Saunders, 2005; Williams & Wood, 2009).

Chapter 3: Method

This study examined item responses (emotional states pertaining to stimuli presented) and performances based on severity level on three assessments of emotion recognition. The following section includes descriptions of participants, criteria for study participants, tasks for data collection, and analysis procedures.

Participants

Participants living with traumatic brain injury (TBI) were recruited from TBI support groups located in Phoenix and Tempe communities. Participants without brain injury who were age and gender-matched with the TBI participants were also recruited and served as the control group. Participants without TBI were recruited from Arizona State University, as well as, from family members of participants with TBI. Inclusion and exclusion criteria for each participant group are as follows. The mean ages for the groups were 35.3 years for the TBI group and 30.8 years for the NI group. Mean years of education were 14.7 years for the TBI group and 15.2 years for the NI group. Groups did not differ significantly for age, $t(45) = 1.26$, $p = .22$, or years of education, $t(45) = .73$, $p = .47$.

Participants with TBI. Twenty-seven participants with TBI were recruited to participate in the study. All participants were required to be proficient in English to ensure accuracy and competency for testing procedures. No restrictions were made regarding gender or race; however, age was limited from 18 to 65 years of age and participants had to be a minimum of one month post onset of the head injury. Participants had sustained a TBI (mild to severe) defined by the Glasgow Coma Scale (GCS) and/or duration of post-traumatic amnesia

(PTA). Mild TBI was defined by a GCS of 13-15 and PTA lasting less than 24 hours. Moderate TBI was defined by a GCS of 9-12 and PTA ranging from 24 hours to 7 days. Severe TBI was defined by a GCS of 8 or less and PTA greater than 7 days. Participants were excluded if: (1) they failed to pass a hearing and/or vision screening; (2) they had any form of documented psychiatric illness; (3) they had any type of pre-existing neurological conditions, such as stroke, dementia, or progressive neurological disease; and/or (4) they had a history of substance abuse within the past 12 months.

Information about the participants with TBI was obtained through medical chart reviews and interviews with the individual. Participants with TBI were grouped according to severity as determined by the GCS score at onset of TBI and length of PTA. Groups included: mild (N = 10), moderate (N = 6), and severe (N = 11).

Neurologically intact (NI) Participants. Family members, spouses, friends, and unrelated cognitively, healthy adults were recruited to participate in the study. NI Participants were matched to TBI participants according to age, gender, and education. NI Participants met the following criteria: (1) hearing and vision acuity within normal limits 2) no history of a documented head injury; (3) no reported history of psychiatric illness; (4) no diagnosis of any neurological conditions; and (5) no history of substance abuse within the past 12 months.

All Participants

To qualify for participation, all potential participants completed vision and hearing screenings. Aided or unaided visual acuity within normal limits was determined by passing a vision screening (Beukelman & Mirenda, 1998). All potential participants were asked if they were color blind; individuals that responded 'yes' were excluded from the study. Aided or unaided hearing acuity within functional limits was determined by performance on the CID List of Everyday Speech (Davis & Silverman, 1978).

Additionally, all participants were administered supplemental cognitive, memory, and perceptual assessments. Participants were administered the *Mini Mental State Examination* (Folstein, Folstein, & Fanjiang, 2001) to quantify cognitive function. To assess non-verbal memory, participants were administered two subtests (i.e. Faces I and II) of the *Wechsler Memory Scale-Revised* (Wechsler, 1997). Unpaired t-tests were performed to compare groups' performances on the MMSE, as well as the Faces I and Faces II subtests. To control for Type I error the Bonferroni approach was used and familywise alpha was set to .0167. With the adjusted p value, groups did not differ significantly on the MMSE, $t(45) = 2.31$, $p = .03$, Face I, $t(45) = 2.11$, $p = .04$, or Faces II, $t(45) = 2.18$, $p = .04$. Finally, all participants completed the *La Trobe Communication Questionnaire* (LCQ; Douglas et al., 2000) to determine perceived communication competence. Groups did not differ significantly on the LCQ. See Tables I through IV for demographic, cognitive, memory, and perceptual data for study participants.

Emotion Recognition Assessments

Two measures of emotion recognition were administered. One measure, the TASIT, included dynamic presentation of the stimuli; whereas, the other measure, the FEEST, included static presentation. Both tests included displays of six basic emotions: sadness, happiness, anger, surprise, anxiety (fear), and disgust.

The Awareness of Social Inference Test (TASIT)

The TASIT featured two versions (A and B) which allowed for multiple administrations to participants without learning effects. The TASIT included three subtests (Part 1, 2, and 3) to examine social perception. In the proposed study, only Part 1: The Emotion Evaluation Test (EET) was administered. The EET was comprised of 28 videoed scenes of actors participating in conversation to assess the ability of the participant to recognize emotion. Each video was approximately 15-60 seconds in length displaying actors participating in everyday situations. In some scenes, there was only one actor (either talking directly to the camera or talking on the phone), whereas other scenes incorporated two actors engrossed in dialogue. If the videos included more than one actor, participants were instructed to focus on one particular actor. Participants completed this assessment twice; once with sound omitted to solely focus on facial expression and eliminate content and vocal cues (i.e. pitch, intonation, volume), and once with sound to determine if additional vocal cues were facilitative in recognizing emotions or acted as a hindrance due to an increase of information to process. Participants were instructed to decide which of the seven emotions (happiness, sadness, anger, surprise, anxiety/fear, disgust, or neutral) was best represented by the actor in the scene. Five display cards, in random order, were provided as possible choices of emotions. According to McDonald et al. (2006), the TASIT yields a test-retest reliability ranging from 0.74-0.88 and alternate forms reliability of 0.62-0.83.

Facial Expressions of Emotion-Stimuli and Tests: Ekman 60 Faces Test (FEEST: E-60-FT)

The FEEST measured the participant's ability to recognize emotion from facial expressions with static images. The study includes the FEEST: E-60-FT (Ekman & Friesen, 1976), which included 10 examples of each emotion for a total of 60 (maximum score) for the overall performance. The E-60-FT was a computerized program in which faces were displayed on the screen for 5 seconds followed by a blank screen. The participant chose the emotion best represented from choices visible on the screen. Responses were not timed; therefore participants took as long as they needed to decide on a particular emotion. Participants were provided with 6 practice items (one for each emotion). When needed, the practice items were re-administered in random order. This assessment required approximately 15-30 minutes to be administered. The reliability and validity of the test items have been confirmed by Young and colleagues (2002).

Experimental Procedures

All participants were individually tested in the Aging and Adult Language Disorders lab at Arizona State University or in the comfort of their own home. Each participant attended 1-2 sessions (depending on participant availability) for a total of approximately 2 hours for study participation time. The session(s) included obtaining informed consent for study participation, administering the inclusion criteria protocol, and administering the emotion recognition assessments. Participants were informed about all study procedures and participant rights before being asked if they would like to participate in the study. If the participant did not wish to participate in the study or did not understand any information presented (i.e. were unable to provide informed consent), the individual was excluded from the study. If the participant agreed to participate in the study, the experimental measures were completed in the same session or during a second session (i.e. due to time or availability restrictions). Order of test administration was randomized across participants and each measure's instructions were followed for test administration. The TASIT: EET (A), required participants to view different videoed scenes. After each videoed scene was presented, the participants were instructed to use their own words or point to the correct answer from a multiple choice array. The participants were allowed to view the video one time only; however, the time needed to respond was not limited. The participants completed the TASIT: EET test with the alternate test form (B) with the sound omitted. The same procedures were followed concerning response time and viewings allowed.

The second facial expression task, FEEST: E-60-FT, instructed participants to view photographs of faces presented on a computer screen. The participants were asked to identify which emotion the individual's face best represented. Consistent with the TASIT: EET, the test only allowed for one viewing (5 seconds in length) with unlimited time for response. The participants were instructed to verbalize the emotion, click on the emotion using the mouse, or point to a choice on the screen to make their selection. Participants were instructed (for both assessments) that only one emotion may be chosen and is the best representation of the emotion displayed.

Data Analyses

In order to determine participants' ability to interpret emotion recognition from facial expressions, data subjected to statistical analyses included raw scores from the experimental measures. The TASIT: EET yielded a total possible score of 28 which included 4 examples of each emotion represented; happy, surprised, sad, angry, anxious, disgusted, and neutral. The FEEST:E-60-FT had a total possible score of 60 which included 10 examples of each emotion represented; happy, surprised, sad, angry, disgust, and fear.

To address the first research question, do TBI and control groups differ on emotion recognition tasks, a mixed analysis of variance (ANOVA) of group (TBI, control) as the between-group factor by emotion recognition tasks (TASIT-EET sound, TASIT-EET no sound, FEEST:E-60-FT) was performed. To address the second research question if emotion recognition ability differs depending on severity of TBI, two, one-way ANOVA with TBI groups (mild, moderate, severe) as the between-group factor were performed; one ANOVA included the TASIT-EET as the dependent variable and the other included the FEEST:E-60-FT as the dependent variable. Finally, to address the third research question, do participants with TBI differ on emotional recognition tasks, a repeated measures ANOVA for emotion recognition task (TASIT-EET sound, TASIT-EET no sound, FEEST:E-60-FT) was performed.

Chapter 4: Results

The study was guided by the following three research questions: (1) To determine if TBI and control groups differ on emotion recognition tasks, (2) To determine if emotion recognition ability using nonverbal cues only differs depending on severity of TBI, and (3) To determine if participants with TBI differ on emotion recognition tasks that include contextual cues (i.e. dynamic) compared to emotion recognition tasks that include only nonverbal cues (i.e. static).

Emotion Recognition across Groups

To determine if participants with and without TBI differed on the emotion recognition measures a 2 x 3 mixed ANOVA was conducted that included group (TBI, control) as the between factor and emotion recognition task (FEEST:E-60-FT, TASIT- EET Sound, TASIT-EET No Sound) as the within factor. A significant main effect was found for group, $F(1, 45) = 16.32$, $p < .001$, but not emotion recognition task, $F(2, 90) = 2.43$, $p = .09$. The control group performed significantly better on the emotion recognition tasks compared to the TBI group. See Table V for groups' means and standard deviations on the tasks.

TBI Severity and Emotion Recognition

To determine if emotion recognition ability using nonverbal cues only differed depending on severity of TBI, one-way ANOVAs were performed. A one-way ANOVA with FEEST:E-60-FT performance as the dependent measure and severity (mild, moderate, severe) as the between group factor was performed. Results indicated a significant effect for severity on the measure, $F(2, 24) = 4.05$, $p = .03$. To better understand the significant effect, planned comparisons were performed. To control for Type I error the Bonferroni approach was used and familywise alpha was set to .0167. The mild TBI group performed significantly better on the FEEST:E-60-FT compared to the severe TBI group, p = .009, no other group comparisons were statistically significant. Results of the one-way ANOVA with TASIT-EET No Sound also indicated a significant effect for severity, $F(2, 24) = 20.60$, $p < .0001$. Once again, controlling for Type I error the Bonferroni approach was used and familywise alpha was set to .0167. The mild group and the moderate group performed significantly better on the TASIT-EET No Sound compared to the severe group. See Table VI for groups' means and standard deviations on the measures.

To address the last research question regarding whether participants with TBI differ on emotion recognition tasks that included contextual cues (i.e. dynamic) compared to tasks that include only nonverbal cues (i.e. static), a repeated measures ANOVA for emotion recognition task (FEEST:E-60-FT, TASIT-EET Sound, TASIT-EET No Sound) was performed. Results indicated a significant main effect, $F(2, 52) = 5.78$, p = .005. Planned comparisons included paired-sample t-tests to better understand the significant effect. Using the Bonferroni approach to control for Type I error, familywise alpha was set to .0167. Results indicated that the TBI participants performed significantly better on the FEEST:E-60-FT compared to the TASIT-EET No Sound, $t(26) = 2.95$, p = .007. No other comparisons were statistically significant. See Table VI for groups' means and standard deviations on the measures.

Post hoc Correlations: Emotion Recognition, Nonverbal Memory, and Perceived Communication Competence

Post hoc analyses were performed to explore the relationship among groups' emotion recognition ability, nonverbal memory, and perceived communication competence. The nonverbal memory tasks included Faces I and Faces II from the Wechsler Memory Scale – III (Wechsler, 1997). The Faces I Recognition subtest requires participants to visually recognize faces immediately after presentation. The Faces II Recognition subtest requires participants to visually recognize faces following a delay of approximately 10-15 minutes. Pearson correlation coefficients were calculated for each group. No statistically significant correlations were found for the NI group among the emotion recognition tasks and the nonverbal memory subtests. Several statistically significant correlations were found for the TBI group among the measures. Significant correlations were found between FEEST:E-60-FT raw scores and Faces I and Faces II raw scores, $r = .55$, $p = .003$, $r = .60$, $p < .001$, respectively. Significant correlations were also found between proportion correct on the TASIT-EET Sound and Faces I and Faces II raw scores, $r = .60$, $p < .001$, $r = .60$, $p < .001$, respectively. Finally, a significant correlation was found between proportion correct on the TASIT-EET No Sound and Faces I and Faces II raw scores, $r = .65$, $p < .001$, $r = .66$, $p < .001$, respectively.

The *La Trobe Communication Questionnaire* (LCQ; Douglas et al., 2000) was completed by all participants and served as the measure of perceived communication competence. No statistically significant correlations were found for either group among the emotion recognition tasks and the LCQ. See Tables VII through VIII for correlation matrices for the NI and TBI groups.

Chapter 5: Discussion

The ability to understand and differentiate emotions is a necessary skill in order to communicate effectively. The current study examined the differences of emotion recognition abilities among individuals with and without TBI. A close examination of differences among the TBI groups was conducted to better understand emotion recognition abilities as it relates to a severity spectrum. Additionally, raw performance scores were analyzed to determine whether contextual cues were facilitative in emotion recognition. This chapter includes a review and discussion of the results for each research question and post hoc correlations, followed by the study limitations, conclusions, and direction for future research.

Review and Discussion of Results

It is well documented that individuals who suffer from severe TBI often report difficulties participating in social settings (e.g., Watts & Douglas, 2006). The ability to understand various facial expressions for emotions during a conversation is important for interpreting the speakers' message and subsequently contributes to communication competence. In previous studies, researchers have limited their investigations to only include participants with severe TBI (e.g., Croker & McDonald, 2005; Knox & Douglas, 2009; Watts & Douglas, 2006); in turn, excluding individuals with less severe presentations who may also present with difficulties in communication competence and emotion recognition. Examining different severity levels and methods of presentation are key to better understand where the differences lie and how these variables affect individuals with TBI. The findings and results of the current study provide a general understanding of ability level in emotion recognition with different TBI severities and which method of presentation is more facilitative for treating these deficits that impact the individual pragmatically. The current study built on existing literature and examined the differences among emotion recognition abilities between individuals without neurological impairment and individuals with TBI, differences among TBI subgroups (i.e. mild, moderate, and severe), as well as, the method of presentation (i.e. dynamic and static).

Emotion Recognition across Groups

The first research question examined whether differences existed between neurologically intact individuals and individuals with TBI. Results demonstrated statistically significant differences between groups. As hypothesized, the individuals in the control group performed significantly better across all emotion recognition tasks compared to the TBI group.

Neurologically intact individuals demonstrated significantly better results across all emotion recognition tasks. These findings support previous research indicating that individuals who have sustained a TBI display impairments in identifying different emotions, regardless of presentation media (Knox & Douglas, 2009; Watts & Douglas, 2006; Croker & McDonald, 2005; Green, Turner, & Thompson, 2003; Williams & Wood, 2009). Despite the naturalistic nature of the emotions displayed in the dynamic presentation and the ability to focus on the specific emotion with the static presentation, individuals with TBI still found the emotions difficult to interpret. Such findings suggest that a greater focus in intervention should be targeted towards addressing their deficit in identifying and understanding emotions from different facial expressions presented.

TBI Severity and Emotion Recognition

The second research question examined whether severity level of the TBI affected the individual's ability to recognize emotions using non-verbal cues only. The TBI group was subdivided into three groups: mild, moderate, and severe. Group was determined by duration of PTA and/or GCS scores. Results demonstrated a significant effect of severity on the non-verbal emotion recognition tasks. The mild TBI group performed significantly better on the FEEST: E-60-FT compared to the severe group. No other group comparisons were significant. When comparing severity levels for the TASIT-EET No Sound task, significant effects of severity on measure were also found. The mild and the moderate group performed significantly better compared to the severe group.

The mild TBI group was significantly better at recognizing emotions compared to the severe TBI group in both dynamic and static displays. Although the moderate TBI group did not differ significantly from the mild and severe for the static display, it is important to examine the mild to severe differences. The nature of each head injury is not an exact science; however, when examining these results, it is clear those individuals' with mild TBI, have a greater understanding and perception of emotions when viewing various facial expressions.

Previous research conducted on emotion recognition has focused predominantly on individuals presenting with severe TBI and these results cannot be generalized across the severity spectrum (Croker & McDonald, 2005; Knox & Douglas, 2009; Watts & Douglas, 2006). In contrast to our results as well as previous findings, Williams and Wood (2009) did not find any statistically significant differences among their two severity levels (i.e., moderate and severe TBI). However, statistically significant differences may not have been present due to a discrepancy of severity level criteria compared to the current study (i.e. duration of PTA). In the current study, mild TBI was determined by PTA duration of 24 hours or less and/or GCS of 13-15, moderate TBI was determined by PTA duration from 24 hours to seven days and/or GCS of 9 to 12, and severe TBI of PTA duration greater than seven days and/or GCS of 3 to 8. Criteria used by Williams and Wood (2009) included moderate TBI characterized by PTA duration of 1 to 24 hours, and severe TBI having PTA duration greater than 24 hours. The differing criteria included a small window of PTA duration for defining moderate impairment and left the severe group with a large range. By not segregating the data into more defined groups, it's possible the data had greater variability making it difficult to find significant results for each severity level. If Williams and Wood (2009) had criteria similar to the current study, they may have found significant group differences across severity level.

The results of the current study indicate that variability in emotion recognition following TBI are present and determining where the individual falls on the severity spectrum may be a good indicator of how the individual will function in a social situation. Further, consistency within the literature for quantifying severity of TBI is necessary for studies to be replicated, as well as interpreting results across studies.

These results may have clinical implications in treatment for adults with TBI. By considering severity levels, it is clear that although individuals with TBI perform more poorly on emotion recognition tasks, differences within each head injury exist and need to be addressed accordingly. Moderate TBI did not differ significantly on the FEEST:E-60-FT but did on the TASIT-EET No Sound, which demonstrates that variability in emotion recognition abilities may be large. Variability between the severity levels indicate that deficits remain present but may be overlooked due to the individual’s ability to functionally participate in social situations. Further, results suggest evaluating emotion recognition in multiple media forms to more accurately identify the individual’s ability to interpret emotions.

To provide appropriate treatment for pragmatic deficits in individuals with TBI, it is important to address the emotion recognition deficits that contribute to communication competence as it relates to the specific individual regardless of TBI severity. The participants with mild TBI performed significantly better on the emotion recognition tasks suggesting that they may be able to functionally participate in social situations; this was not the case for study participants with severe TBI presentation. Mild and moderate head injuries are often overlooked due to their ability to function in various settings, but these emotion recognition deficits may be hidden by other residual pragmatic skills. All severities of TBI should be evaluated with emotion recognition tasks to determine the extent of impact these deficits may have on the individual's communicative abilities. Although significant results were found, they should be interpreted cautiously as a larger N is required to perform additional analyses (i.e., mean comparisons between each severity group and the control group) and better understand the extent of emotion recognition abilities across the severity spectrum of TBI.

Emotion Recognition and Media Presentation

The third research question addressed whether TBI participants performed better on tasks that included contextual cues (i.e. dynamic display) compared to tasks that only included non-verbal cues (i.e. static). The results indicated a significant main effect for emotion recognition tasks. The TBI participants performed significantly better on the FEEST:E-60-FT compared to the TASIT-EET No Sound. No other comparisons were statistically significant.

The current study demonstrated that individuals with TBI found the static display (i.e. photographs) to be more facilitative for identifying emotions than a dynamic display without sound. In previous studies, different results have emerged. For example, McDonald and Saunders (2005) and Williams and Wood (2009), found that their TBI participants performed better with the dynamic display compared to static display. However, Knox and Douglas's (2009) results support the current findings of greater success in emotion recognition with a static presentation.

Static measures may be easier for individuals with TBI to identify emotions for multiple reasons. Possibly, having only a face in a static picture is less attention demanding for the individual with TBI; thus they are able to more accurately identify the emotion displayed. Observing static stimuli provides the participant with the opportunity to attend to the task without having to integrate and store additional information that is being processed. Moreover, static displays are less attention demanding because the individual needs to attend to only face; whereas, the dynamic displays often included multiple actors which may have been distracting and attention demanding for the individuals with TBI.

Dynamic displays may be more difficult for emotion recognition due to the additional cues provided in context. Although the participant is given more cues to help determine which emotion is the most appropriate option, additional cues can serve as too much information to process. Body language and gestures can serve as added distractions as opposed to facilitative cues. Additionally, the dynamic display occasionally included one or more actor in each scene and the participant was instructed to focus on a specific actor which may have been affected by attention deficits. Emotions presented in real time with the appropriate facial movements can possibly be distracting to the participant. With facial features moving quickly; reduced processing speed may affect the individual with TBI's ability to effectively process the multiple facial movements' (i.e. furrowed brow, widened eyes) contextual information which may be confusing for the individual rather than facilitative. This conclusion of attention deficits as a contributing factor is speculative as no attention measure was included in the current study. However, based on our results and previous research, investigating attention ability and its relationship to recognizing emotion in different media presentations is warranted to have a better understanding of how cognitive functions contribute to communication competence in individuals with TBI.

In addition to comparing media presentation between the TBI group and the control group, further exploration of performance based on severity level for different media presentations needs to be addressed. The mean scores for the mild TBI group were better in both media presentations and very similar (i.e., .83 for static vs .85 for dynamic); whereas a larger difference between mean scores was found for the severe group (i.e., .70 for static vs .53 for dynamic). Future investigations should investigate what factors contribute to the large decline in performance between media presentations as TBI severity increases.

The use of additional cues (i.e. sound) did not reveal statistically significant results but should still be considered for therapeutic intervention. These results indicate an important starting point for individuals with emotion recognition deficits. Treatment plans and hierarchies should reflect tasks that are most facilitative initially and then be structured to increase the difficulty level and generalize to the most naturalistic social setting which would be consistent with the results of the current study. Starting individuals with identified emotion recognition deficits with pictures (i.e., static) and moving towards a more naturalistic presentation of videos (i.e., dynamic) would be most facilitative for better identifying emotions from facial expressions. Contextual cues should be added in as the individual increases his/her accuracy in emotion recognition of static stimuli. The results suggest that the dynamic display did not provide helpful cues, but instead acts as a barrier to recognize the desired emotion. These results are important for both evaluation of emotion recognition abilities and treatment of pragmatic deficits.

Post hoc Correlations: Emotion Recognition and Nonverbal Memory

Post hoc analyses were performed to determine the relationship among the groups' emotion recognition abilities and nonverbal memory. The nonverbal memory tasks used were the WMS-III (Wechsler, 1997) subtests Faces I and Faces II. The subtests required individuals to observe different faces and visually recognize them immediately following presentation and then again after a delay (approximately 10-15 minutes). Results indicated that no statistically significant correlations were found for the NI group, however many statistically significant correlations were found for the TBI group among different emotion recognition tasks. Significant correlations were found among all three emotion recognition tasks and the two nonverbal memory tasks. These findings suggest that nonverbal memory ability may contribute to the ability to accurately recognize emotions depicted in static and dynamic displays in individuals with TBI. Individuals with TBI were unable to either recognize the various faces initially or failed to successfully store them for delayed retrieval.

Performance on the La Trobe Communication Questionnaire (self report) was evaluated and revealed no significant relationships with the emotion recognition tasks and no significant differences between the control group and the TBI group. Watts and Douglas (2006) explored the relationship between the LCQ-other which was completed by close friends or family and the LCQ-self report. Results of their study indicated that a significant correlation existed between the LCQ-other report and the TBI group's performance on emotion recognition tasks. The significant others rated the TBI participants communication more accurately than the TBI groups rated themselves on the LCQ-self report in comparison to their performance on the emotion recognition tasks. In the current study, both control participants and TBI participants completed the LCQ-self report to rate their own communication perceptions. Results of the current study are not statistically significant, but may be consistent with findings from Watts and Douglas (2006) because TBI participants may not accurately perceive their own communication abilities. Further investigation should replicate the study design employed by Watts and Douglas (2006) with the addition of both a static and dynamic media presentation. Finally, additional exploration should address the relationship between the LCQ and severity groups.

Study Limitations

As with many previously conducted studies, the small number of study participants included proves to be a consistent limitation. Although this study yielded statistically significant results, results of this study should be interpreted cautiously due to the small number of participants within each severity group. A greater sense for the level of severity that coincides with the degree of emotion recognition deficits would have been provided if mean comparisons were done with each severity level compared to the control group. The current study did not include these comparisons due to the limited number of participants in each severity group. Further investigations should include a larger N for each severity group. The current study was also only able to speculate about the involvement of attention impairments on performance for emotion recognition tasks. Future investigations should include tasks to measure attention abilities.

In addition to using a larger sample size, more detailed inclusionary criteria would have provided a more in-depth analysis of the TBI group. Criteria detailing the participant's time post onset, cause of injury, and whether the injury was open or closed would have provided more descriptive results among the severity groups.

Conclusions

In summary, the results of the study indicate that TBI participants present with impaired emotion recognition abilities when compared to age and education matched controls; and, these findings replicate and extend previous research. Further, the TBI participants differed significantly across severity levels, with mild TBI participants performing better than severe participants for the static measure, and both mild and moderate participants performing significantly better on the dynamic measure without sound compared to the severe group. Additionally, results indicated that TBI participants performed significantly better on the static measure than the dynamic measure.

Post hoc correlations indicated a significant correlation between performance on the nonverbal memory tasks and emotion recognition tasks. Although questionnaires were completed, no significant correlations were found among emotion recognition tasks and personally perceived communication abilities. However, findings from the current study may be consistent with results from Watts and Douglas (2006), indicating that no significant relationship was found between the LCQ and performance scores because of inaccuracies in communication perceptions by the participants with TBI.

Future research should continue to examine emotion recognition ability among TBI patients across the severity spectrum. Results of the study suggest that individuals with TBI may present with impaired abilities to recognize and understand emotions based on facial expressions; which in turn, may impact communication competence for daily activities and social functioning. Individuals with TBI and their respective family members may benefit from intervention and education focused on emotion recognition to improve social skills and increase confidence in communicative situations.

Future Research

Although the findings from this study yielded significant results, additional variables would further prove to benefit this field. Future research focusing on type of injury (i.e. open or closed) and damage (i.e. localized or diffuse) would provide researchers, clinicians, and neurologists with a better understanding of how communicative abilities are affected according to each respective injury. Another area of interest is whether performance is different based on affective valence (i.e. positive versus negative emotions). Additionally, greater focus on gender differences and time post onset would provide interesting results. Finally, more emphasis should be placed on the effects that these deficits place on activities of daily living and occupation.

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APPENDIX A.

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Heather Wright COOR
From:	Mark Roosa, Chair Soc Beh IRB
Date:	10/08/2010
Committee Action:	**Expedited Approval**
Approval Date:	10/08/2010
Review Type:	Expedited F5 F7
IRB Protocol #:	1009005445
Study Title:	Emotion Recognition and Traumatic Brain Injury
Expiration Date:	10/07/2011

The above referenced protocol was approved following expedited review by the Institutional Review Board.

It is the Principal Investigator's responsibility to obtain review and continued approval before the expiration date. You may not continue any research activity beyond the expiration date without approval by the Institutional Review Board.

Adverse Reactions: If any untoward incidents or severe reactions should develop as a result of this study, you are required to notify the Soc Beh IRB immediately. If necessary a member of the IRB will be assigned to look into the matter. If the problem is serious, approval may be withdrawn pending IRB review.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, or the investigators, please communicate your requested changes to the Soc Beh IRB. The new procedure is not to be initiated until the IRB approval has been given.

Please retain a copy of this letter with your approved protocol.

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Table I. *Descriptive data for TBI and NI groups*

Participant Information		
	TBI[1]	NI[2]
Age	35.3(12.6)	30.8(11.6)
Education	14.7(2.1)	15.2(2.0)
MMSE[3]	28.5(1.8)	29.55(0.5)
Faces I	34.4(5.1)	37.6(5.0)
Faces II	35.7(5.7)	38.9(3.5)
LCQ[4]	58.2(12.4)	54.0(6.4)

[1]Traumatic Brain Injury; [2] Neurologically Intact; [3] Mini Mental State Examination; [4]La Trobe Communication Questionnaire

Table II. *Descriptive data for Mild TBI group*

Participant	Age	Gender	Edu[2] (Years)	Race	Neuro Report	MMSE[1]	Faces I	Faces II
				MILD				
1	23	M	16	C	N	30	37	33
2	23	F	18	H	N	30	40	35
3	24	M	16	NA	N	30	42	45
4	27	M	15	C	N	28	27	35
5	22	F	17	C	N	30	36	41
6	25	M	12	C	N	26	41	38
7	28	F	17	C	N	30	44	43
16	36	M	16	C	N	28	37	30
25	24	M	18	C	N	30	34	44
30	57	F	14	C	N	30	38	40
Mean	28.9		15.9			29.2	37.6	38.4
(SD)	(10.6)		(1.8)			(1.3)	(4.7)	(5.0)

[1] Mini Mental State Examination; [2] Education

Table III. *Descriptive data for Moderate TBI group*

Participant	Age	Gender	Edu[2] (years)	Race	Neuro Report	MMSE[1]	Faces I	Faces II
MODERATE								
11	24	M	16	C	N	30	36	35
12	34	M	12	AA	N	27	31	35
14	53	M	14	C	N	29	35	42
23	24	F	16	C	N	30	41	42
24	59	M	14	C	N	29	37	37
29	47	M	18	C	N	29	36	40
Means	40.1		15			29	36	38.5
(SD)	(15.0)		(2.1)			(1.1)	(3.2)	(3.2)

[1]Mini Mental State Examination; [2] Education

Table IV. *Descriptive data for Severe TBI group*

Participant	Age	Gender	Edu[3] (years)	Race	Neuro Report	MMSE[1]	Faces I	Faces II
				SEVERE				
8	23	M	14	C	N	30	36	35
9	28	F	12	C	GCS[2] 3	30	34	39
10	38	F	12	C	N	27	30	24
13	22	F	11	C	N	28	30	37
15	36	M	14	C	GCS 6	30	34	39
18	54	F	14	C	N	26	29	28
19	35	F	12	C	GCS 6	23	25	28
20	41	F	16	C	GCS 3	28	36	31
21	51	M	12	C	GCS 3	28	28	29
22	43	F	14	C	N	27	25	26
27	54	M	18	C	N	30	30	34
Means (SD)	38.6 (11.4)		13.5 (2.1)			27.9 (2.1)	30.6 (3.9)	31.8 (5.2)

[1] Mini Mental State Examination; [2]Glasgow Coma Scale; [3] Education

Table V. *Mean Emotion Recognition Task Scores, reported as proportion correct, and standard deviations (SD) for the TBI and Control Groups*

	TBI[1] Group (N = 27)		Control Group (N = 20)	
Task	*M*	*SD*	*M*	*SD*
FEEST[2]	.76	.12	.84	.06
TASIT-Sound[3]	.76	.17	.88	.06
TASIT-No Sound[4]	.66	.22	.88	.06

[1]Traumatic Brain Injury; [2] Facial Expressions of Emotion-Stimuli and Tests; [3]The Awareness of Social Inferences Test-Sound; [4]The Awareness of Social Inferences Test-No Sound

Table VI. *Mean Emotion Recognition Task Scores, reported as proportion correct, and standard deviations (SD) for the TBI mild, moderate, and severe groups.*

	Mild Group (N = 10)		Moderate Group (N = 6)		Severe Group (N = 11)	
Task	*M*	*SD*	*M*	*SD*	*M*	*SD*
FEEST[1]	.83	.09	.77	.14	.70	.12
TASIT-Sound[2]	.87	.08	.74	.12	.66	.19
TASIT-No Sound[3]	.85	.07	.71	.12	.53	.14

[1]Facial Expressions of Emotion-Stimuli and Tests; [2] The Awareness of Social Inferences Test- Sound; [3] The Awareness of Social Inferences Test- No Sound

Table VII. *Pearson correlations between emotion recognition, nonverbal memory, and perceived communication competence measures for the NI group (N = 19).*

	WMS[1]- III Faces I	WMS-III Faces II	LCQ[2]
FEEST[3]	.40	.06	.15
TASIT-Sound[4]	.25	.15	.27
TASIT-No Sound[5]	.22	.19	.00

[1] Wechsler Memory Scale III-Revised; [2] La Trobe Communication Questionnaire; [3] Facial Expressions of Emotion-Stimuli and Tests; [4] The Awareness of Social Inferences Test- Sound; [5] The Awareness of Social Inferences Test-No Sound

Table VIII. *Pearson correlations between emotion recognition, nonverbal memory, and perceived communication competence measures for the TBI group (N = 27).*

	WMS[1]- III Faces I	WMS-III Faces II	LCQ[2]
FEEST[3]	.54*	.60*	.22
TASIT-Sound[4]	.60*	.60*	.14
TASIT-No Sound[5]	.65*	.66*	.00

*p < .01

[1] Wechsler Memory Scale III-Revised; [2] La Trobe Communication Questionnaire ; [3] Facial Expressions of Emotion-Stimuli and Tests; [4] The Awareness of Social Inferences Test- Sound; [5] The Awareness of Social Inferences Test-No Sound