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An Analysis of Non-Verbal Emotion Recognition in Individuals with Traumatic Brain Injury

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Thesis Signature Page

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An Analysis of Non-Verbal Emotion Recognition in Individuals with Traumatic Brain Injury

By

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Abstract

Approximately 1.5 million people suffer traumatic brain injury each year in the United States. Over 5% suffer from long-term disability or cognitive deficits, including loss of executive functions, reduced processing speed, and emotional processing deficits. While research exists examining facial affect recognition and emotional prosody deficits in individuals with traumatic brain injuries, less is known about the how these two emotional processing deficits relate to one another; whether age, education, or time since injury effect deficits; and how these specific deficits impact quality of life. This study conducted a secondary data analysis to examine the relationship between demographic variables and facial affect recognition and prosody deficits. This study also conducted a secondary data analysis investigating the relationship between facial affect recognition and prosody deficits. Additionally, a secondary data analysis was conducted to examine how quality of life in clinical populations with traumatic brain injury relates to deficits in both facial affect recognition and prosody. An analysis of demographic data, emotional processing, and quality of life was conducted using previously collected data from 19 individuals with moderate-to-severe traumatic brain injury, who were enrolled in an ongoing intervention study at the Kessler Foundation. Results showed a meaningful relationship between prosody deficits and years of education, but no relationship between facial affect recognition and prosody deficits. Future research should utilize quality of life measures that are more sensitive to socio-emotional aspects of quality of life.

Keywords: traumatic brain injury; emotional processing; facial affect recognition; vocal prosody; nonverbal communication; quality of life; social functioning

AN ANALYSIS OF NON-VERBAL EMOTION RECOGNITION IN INDIVIDUALS WITH TRAUMATIC BRAIN INJURY

A THESIS

Submitted in partial fulfillment of the requirements

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by

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An Analysis of Non-Verbal Emotion Recognition in Individuals with Traumatic Brain Injury

Approximately 1.5 million Americans a year suffer from a traumatic brain injury (TBI; Thurman, Alverson, Dunn, Guerrero, & Sniezek, 1999). TBI results from an injury due to an external force and can result in a range of deficits and symptoms. Among individuals that sustain a TBI, 80,000 experience long-term disability and cognitive deficits, such as reduced processing speed, executive functioning, and emotional processing capabilities (Thurman et al., 1999). Two areas that showed marked deficiencies following TBI are the processing of facial and auditory emotion (Adamaszek et al., 2014; Adolphs et al., 1999; Adolphs, Damasio, & Tranel, 2002; Adolphs & Tranel, 1999; Hornak, Rolls, & Wade, 1996; Kucharska-Pietura, Phillips, Gernand, & David, 2003; Pell, 1998; Spell & Frank, 2000; Zupan, Neumann, Babbage, & Willer, 2009).

The terms used for facial and auditory emotion perception are facial affect recognition (FAR) and prosody respectively. Broadly defined, FAR and prosody are respectively the comprehension and processing of the facial and auditory emotional expressions of others. Deficits in both FAR and prosody are shown to cause difficulties in social functioning, particularly in forming meaningful relationships with others (Babbage et al., 2011; Calder & Young, 2005; Croker & McDonald, 2005; Edwards, Jackson, & Pattison, 2002; Edwards, Pattison, Jackson, & Wales, 2001; Frieden, Houry, & Baldwin, 2010; Grinspan, Hemphill, & Nowicki, 2003; Hooker & Park, 2002; Horning, Cornwell, & Davis, 2012; Martins et al., 2011; Maurage et al., 2009; Radice-Neumann, Zupan, Babbage, & Willer, 2007; Schmidt, Hanten, Li, Orsten, & Levin, 2010; Sparks, McDonald, Lino, O'Donnell, & Green, 2010; Williams et al., 2009). While

development of interventions for FAR or prosody aid clinical populations recover functional levels of this important social ability, the literature shows mixed evidence as to whether FAR and prosody deficits are related (Amminger et al., 2012; Edwards et al., 2002; Mcdonald, 2005). If FAR and prosody deficits are linked, then interventions designed to treat one could potentially aid in the treatment of the other. However, if prosody is not related to FAR, then different interventions need to be implemented for the treatment of these two distinct emotional processes. As such, the current study seeks to examine how FAR and prosody deficits are related in an effort to improve their treatment within individuals with TBI.

Facial Affect Recognition

FAR is the ability to visually process and identify emotions present in facial expressions, a process by which we assess the disposition of others (Ekman, 1977). Measures used in studies examining FAR typically consist of images of individuals displaying facial expressions consisting of six emotions: happiness, anger, fear, surprise, sadness, and disgust. Labeling tasks are the primary measures used, where emotional expressions are shown, and the participant responds by selecting which emotion the face represents from an array of emotional words. Successful facial affect recognition relies on the ability to perceive emotions from facial expressions, as these expressions are the most common type of emotional communication (Adolphs et al., 2002; Williams & Gordon, 2007). The failure to recognize other's emotions accurately has been shown to lead to difficulty in social relationships, misunderstanding other's affect, and inappropriate responses to emotions (Babbage et al., 2011; Croker & McDonald, 2005).

Facial emotional processing utilizes a broad array of brain areas, acting as a distributed process. Areas of activation in facial emotional processing include the parietal lobe, medial and dorsolateral prefrontal cortex, and orbitofrontal cortex in the frontal lobe, the limbic system, and the superior temporal sulcus, fusiform gyrus, and inferior temporal gyrus in the temporal lobe, among others (Calder & Young, 2005; Jehna et al., 2011; Martins et al., 2011; Phan, Wager, Taylor, & Liberzon, 2002; Prigatano & Pribram, 1982; Radice-Neumann et al., 2007; Rapcsak et al., 2000; Spikman et al., 2013; Ward, Calder, Parker, & Arend, 2007; Williams et al., 2009; Williams & Wood, 2010; Yim, Babbage, Zupan, Neumann, & Willer, 2013). Many of these same brains areas are ones impacted by TBI (Calder & Young, 2005; Jehna et al., 2011; Radice-Neumann et al., 2007; Williams et al., 2009).

Deficits in FAR can result in difficulties relating to and understanding the emotions of others, which can significantly hamper social relationships, and show prevalence within clinical populations (Babbage et al., 2011; Calder & Young, 2005; Croker & McDonald, 2005; Edwards et al., 2002, 2001; Grinspan et al., 2003; Hooker & Park, 2002; Horning et al., 2012; Kucharska-Pietura, David, Masiak, & Phillips, 2005; Martins et al., 2011; Maurage et al., 2009; Radice-Neumann et al., 2007; Schmidt et al., 2010; Sparks et al., 2010; Tseng et al., 2013; Williams et al., 2009). The deficits and effects shown in these studies are important to clinical populations, as they illustrate that weakened ability to identify FAR can impede social capabilities, which can negatively affect their quality of life. However, do these effects occur in healthy and clinical populations with deficits in forms of emotional processing such as prosody?

Prosody

Prosody, sometimes referred to as vocal affect recognition, is the recognition of emotions through tone of voice, where changes in vocal traits such as timbre, speech rate, pitch, timing, and loudness, can radically alter the perceived emotion (Edwards et al., 2002, 2001; Pell, 1998). Studies that examine prosody utilize vocal recordings of an individual stating the same sentence with varying inflections, indicating one of six emotions: happiness, anger, sadness, surprise, fear, and disgust. Areas that active in processing prosody are also distributive. Some of the more active areas associated with prosodic processing include the right inferior frontal cortex, the bilateral frontal pole, right and left front parietal operculum, and the amygdala (Adolphs et al., 1999, 2002; Adolphs & Tranel, 1999; Frühholz & Grandjean, 2013). Though there is not as much research into prosody as there are into FAR deficits, similar difficulties in social engagement have been shown in clinical populations with schizophrenia and with limited research examining psychosis and alcoholism (Amminger et al., 2012; Hooker & Park, 2002; Kucharska-Pietura et al., 2005; Maurage et al., 2009; Tseng et al., 2013). The clinical importance of the deficits examined in these studies illustrate that weakened prosodic recognition can encumber socialization, which has a negative effect on quality of life. While research has studied the relationship between prosody deficits and difficulty socializing in some clinical populations, this has not been examined in individuals with TBI.

Facial Affect Recognition & Prosody

People often exhibit emotional cues in complex ways, displaying facial and emotional cues simultaneously. From the squinted face of a laughing child, to the

furrowed brow of a disgruntled person, emotional perception works to assemble these visual and auditory signals and combine them to create a mental construct of these complicated emotional states. There is limited research examining the relation between deficits in FAR and prosody. Much of the studies examining this relationship are in clinical populations with schizophrenia, with only a single study in psychosis and alcoholism respectively (Amminger et al., 2012; Edwards et al., 2002, 2001; Hooker & Park, 2002; Kucharska-Pietura et al., 2005, 2003; Maurage et al., 2009; Tseng et al., 2013). While one study looked at both FAR and prosody deficits in individuals with TBI, it looked at those deficits independently and did not examine the relationship between FAR and prosody deficits (Spell & Frank, 2000). This demonstrates a lack of research examining the nature of the relationship between FAR and prosody deficits that the current study seeks to address.

Most studies utilize separate measures to examine FAR and prosody measures, however the Diagnostic Analysis of Nonverbal Accuracy 2 (DANVA-2) is a test designed to evaluate both FAR and prosody within the same measure. Typical measures in these studies consist of emotional facial expression labelling tasks consisting of slides with faces displaying anger, sadness, happiness, disgust, surprise, and fear, as well as a selection of emotional words from which the face would be 'labelled' (Amminger et al., 2012; Edwards et al., 2002, 2001; Hornak et al., 1996; Kucharska-Pietura et al., 2005, 2003; Maurage et al., 2009). Separate recognition tests of affective prosody, employing actors who spoke sentences in a variety of emotional intonations, are also utilized (Amminger et al., 2012; Edwards et al., 2002, 2001; Hornak et al., 1996; Kucharska-Pietura et al., 2005, 2003; Maurage et al., 2009). Results from these studies showed

marked deficits of emotional processing across both facial and vocal mediums among individuals with schizophrenia, alcoholism, and pervasive developmental disorders (Amminger et al., 2012; Edwards et al., 2002, 2001, Kucharska-Pietura et al., 2005, 2003; Maurage et al., 2009; Serra, Jackson, Van Geert, & Minderaa, 1998). The current study utilizes the DANVA-2 because it examines both FAR and prosody in the same standardized measure.

The DANVA-2 (Baum & Nowicki, 1998; Nowicki & Carton, 1993; Nowicki, 2008) is a computerized measure designed to assess the processing of nonverbal emotional information, including facial expressions and tone of voice. The DANVA-2 subtests identify deficits by examining an individual's ability to recognize and identify both facial and vocal emotions, which is measured via accuracy of the response. Participants identify one of four possible emotions (fear, happiness, anger, sadness) which are displayed on male and female faces and voices of either adults or children. The test was initially developed to examine FAR and prosody in individuals expressing Dyssemia – difficulty with processing or expressing nonverbal communication – but has since seen use examining deficits in other clinical populations, including bipolar disorder, attention-deficit hyperactive disorder (ADHD), schizophrenia, schizotypal personality disorder (Miller, Hanford, Fassbender, Duke, & Schweitzer, 2011; Pan, Tseng, & Liu, 2013; Seymour et al., 2013; Tlustos et al., 2011; Tseng et al., 2013). Only one study utilized the DANVA-2 it examine in individuals with TBI, but they examined FAR and prosody deficits independently of other another rather than in relation (Spell & Frank, 2000).

A study conducted by Pan, Tseng, & Liu (2013) examined the effects of different phases of bipolar disorder on facial affect recognition in a sample of 29 manic and 16 remitted Han-Chinese bipolar participants, compared against a group of 40 age and sex-matched healthy controls. The results from this study indicate that FAR capabilities worsened in individuals with bipolar disorder, in that manic individuals often had difficulty maintaining attention to respond, and gave less accurate responses than either euthymic or healthy individuals. Miller et al. (2011) utilized the DANVA-2 to examine a clinical sample of 51 adults (17 women, 34 men) with ADHD, divided by diagnosis type; ADHD-combined type (n = 17), ADHD-inattentive type (n = 16), and a healthy control group (n = 18). Results suggested that adults with ADHD showed impairments in both facial and vocal affect recognition when compared to healthy controls, with hyperactive and inattentive disorders showing stronger deficits than other forms of ADHD. Results from these studies indicate that the DANVA-2shows effectiveness in identifying deficits FAR and prosody deficits via an individual's ability to respond quickly and accurately.

While studies examining other clinical populations using the DANVA-2 are numerous, the body of research in TBI utilizing the DANVA-2 to examine both FAR and prosody is limited to one study. Spell & Frank (2000) examined nonverbal affect recognition in a sample of 24 individuals with TBI compared against 24 healthy matched controls. Individuals in the TBI group were recruited from various rehabilitation facilities and universities in South Carolina at least 1-year post injury. The author's rationale for utilizing the facial and vocal subtests of the DANVA2 was that it had shown reliability and validity in adult populations, and that it contained faces and voices of both male and female adults and children across multiple racial and cultural backgrounds. The

results showed that individuals with TBI displayed marked deficits in the recognizing emotions in younger adult faces and voices, correctly identifying 78% of facial emotions compared to the 83% correct in healthy controls, and 66% of correctly identified vocal emotions compared to 72% of controls.

Facial Affect Recognition & Traumatic Brain Injury

Research investigating FAR capabilities have observed deficits in over 38% of individuals with TBI (Croker & McDonald, 2005; Green, Turner, & Thompson, 2004; Jackson & Moffat, 1987; McDonald & Flanagan, 2004; Milders, Fuchs, & Crawford, 2003; Spell & Frank, 2000; Spikman et al., 2013). Specifically, studies have shown that persons with TBI exhibit greater impairments in FAR in comparison to non-brain injured individuals (Croker & McDonald, 2005; Green et al., 2004; Jackson & Moffat, 1987; Kok et al., 2014; McDonald & Flanagan, 2004; Milders et al., 2003; Spell & Frank, 2000; Spikman et al., 2013). Croker & McDonald (2005) examined how 24 individuals with severe TBI and 15 matched non-brain injured individuals by conducting a facial identification, facial affect labelling, and matching task. In the labelling task, individuals were asked to label the emotion they were shown based on an array of six possible emotions – sadness, anger, disgust, fear, surprise, and happiness – presented to them along with the image. In the matching task, participants were asked to identify whether the emotions displayed on two separate faces were identical or different. Results showed that individuals with TBI showed significant deficits in both facial affect matching and labelling tasks, but showed improvement when given a contextual framework to work with regarding which emotions were which. These findings are meaningful because not only do they show the marked difference between the emotional identification

capabilities of healthy individuals and individuals who have suffered a TBI, but also that meaningful recovery from these deficits is possible through methods such as interventions.

These impairments are shown under a variety of testing circumstances, including matching, recognition, labeling, facial discrimination, questionnaires, and an assortment of cognitive and psychosocial measures (Croker & McDonald, 2005; Green et al., 2004; Milders et al., 2003; Spikman et al., 2013; Tlustos et al., 2011; Watts & Douglas, 2006) . Milders et al. (2003) examined the difference between 17 patients with severe TBI compared with matched healthy controls. The study utilized questionnaires – which were given to both the participants and their relatives to get multiple perspectives on the same individuals – as well as facial identification, emotional labelling and matching tasks, theory of mind tests, and cognitive fluency tasks. Results showed that individuals with TBI were significantly impaired at identifying facial emotions compared to healthy individuals. Questionnaires from both relatives and the patients indicated that emotional/social behaviors were altered after brain injury occurred. TBI participants also showed marked deficits in non-verbal fluency and identifying social faux pas. These results are meaningful because they show these deficits are found across a spectrum of testing measures. Deficits of non-verbal fluency and faux pas identification indicate that deficits of emotional processing have a definitive effect on an individual's ability to engage in successful social encounters.

Further efforts have revealed that individuals with TBI show greater impairments in FAR when identifying negative emotions (i.e., sadness, anger) compared to positive emotions (i.e., happy, surprised; Calder, Keane, Manes, Antoun, & Young, 2000; Croker

& McDonald, 2005; Williams & Wood, 2010). Facial affect recognition deficits in TBI have been detected regardless of whether static (i.e. photograph), or dynamic display (i.e. video) methods are used in stimuli delivery (Knox & Douglas, 2009; Williams & Wood, 2010). Williams & Wood (2010) examined emotion recognition following TBI. The study explored whether emotion recognition differed because of the type of media used to present stimuli, and whether emotional valence (i.e., positive or negative emotions) of the stimuli had an effect on recognition.

Divergent from other concomitants of TBI that establish a course of improvement post-TBI, research has noted that deficits in facial affect recognition remain stable over time (Knox & Douglas, 2009). The firmness of these deficits following TBI shows that said impairments impact individuals with TBI consistently across their lifespan, and do not appear to diminish over time. As such, the identification of effective treatments to improve these deficits is crucial to the general functioning and quality of life of individuals with TBI.

Prosody & Traumatic Brain Injury

Similar to FAR research, studies exploring prosodic capabilities have also observed significant deficits among individuals with TBI compared to individuals without brain injury, with prosodic deficits present in 80% of severely injured individuals (Adolphs et al., 2002; Adolphs & Tranel, 1999; Dimoska, McDonald, Pell, Tate, & James, 2010; McDonald et al., 2013; Spell & Frank, 2000). Dimoska, McDonald, Pell, Tate, and James (2010) examined prosodic deficits further in a study of 18 individuals with moderate-to-severe TBI. Researchers found that prosodic deficits showed a significant increase relative to the severity of the injury (Dimoska et al., 2010).

Rushby et al. (2014) used a discrimination task to show differences in prosodic deficits. This measure presented participants with a semantically neutral word alongside a prosodic voice stimuli while recording accuracy and electroencephalogram activity. The results from this study varied from general findings in that they found that clinical populations with TBI did not differ significantly in their ability to process sensory stimuli or recognize the salience of emotional acoustic cues. However, participants showed deficits in evaluative and cognitive judgement capabilities which resulted in a decreased ability to identify vocal emotions (Rushby et al., 2014). While the latter of these two studies suggests that individual's prosodic recognition capabilities are not diminished, it does not identify the types or severity of the injuries that participants sustained. It also confirms that a deficit – albeit not emotional – was present, and effected the participant's prosodic ability (Rushby et al., 2014). The results of these two studies are significant to clinical populations in that, despite the variability presented by differing types of TBI, there is a general gradient connection between TBI and prosodic deficits.

Emotional Impairment in TBI across Facial Affect Recognition & Prosody

Affected brain areas and severity of injury are heterogeneous; different traumatic events can result in varying levels of damage to a wide range of brain areas, depending on the circumstances. Research had indicated that FAR deficits are present in as much as 40% of individuals with TBI (Babbage et al., 2011). However, such figures cannot be shown for prosody deficits in individuals with TBI. Furthermore, there is a lack of research examining how FAR and prosody deficits interact. Individuals experience the facial expressions and vocal tones of other people simultaneously. When an individual sees and hears a person scowling and yelling, the brain processes this input to assemble a

comprehensive understanding of that person's emotional state. If an individual with TBI has trouble recognizing and processing emotional faces, does it affect their prosodic recognition?

Zupan, Neumann, Babbage, and Willer (2009) recognized this connection, stating that injuries to neural substrates which were shared between FAR and prosody would negatively affect emotional processing in both of these emotional processing modalities. Zupan et al.'s review examined the separate fields of both FAR and prosody extensively, but noted only four studies examining the link between the two. Hornak, Rolls, and Wade (1996) examined the deficits in both FAR and prosody deficits in a clinical sample of 23 individuals with TBI. Participants were separated into two groups based on the location of the brain damage – 'ventral frontal' and 'non-ventral' groups, respectively – then were tested for FAR and prosodic deficits. The FAR task consisted of an array of emotional faces (disgusted, sad, frightened, angry, happy, surprised, and neutral) taken from the Ekman series, where participants would view the face and select the emotion they thought was present from a list of provided emotional adjectives. The prosodic task consisted of emotional non-verbal sounds (puzzled, disgusted, contented, sad, frightened, angry, and neutral), which participants would listen to and select the emotion in a manner identical to the FAR task. Results indicated that individuals with TBI showed diminished capabilities in completing both modality tasks.

Similarly, Harciarek, Heilman, and Jodzio (2006) examined FAR and prosodic deficits in 30 individuals with right hemisphere damage, and compared them against 31 healthy controls. Results indicated that individuals with TBI showed deficits in in processing both facial and auditory emotions, but that the levels of their FAR and

prosodic deficits varied individually, which agrees with the findings of Hornak et al. (1996). The findings of these studies are key to FAR and prosody research as they suggest that there are still components of FAR and prosody that operate independently, deficits in one modality significantly relate to deficits in the other, despite differences in injury.

Current Experiment

Emotional processing deficits in individuals with TBI include both FAR and prosody. While studies have examined how FAR deficits effect quality of life in individuals with TBI, no research examines this effect in prosody deficits. Furthermore, there is virtually no research examines the impact of prosody deficits on quality of life, and whether deficits in one will co-exist with deficits in another. The current study seeks to fill the void in the research by examining these relationships in individuals with TBI:

Hypothesis 1: Demographics of the sample including years of education, months since injury, and age will be positively correlated with performance on FAR and prosody tasks in individuals with moderate-to-severe TBI.

Hypothesis 2: Performance on FAR and prosody tasks will be positively correlated in a sample of individuals with moderate-to-severe TBI.

Hypothesis 3: Individuals with FAR/prosody deficits will have decreased quality of life. FAR deficits have been related to decreased quality of life in individuals with TBI, and in prosody deficits in other clinical populations, but the examining of prosody deficits on quality of life has not been explored.

Methodology

Experimental Overview

The current study utilized previously collected data as part of an ongoing randomized control trial treating emotional processing impairments in individuals with TBI. All data was de-identified in the database prior to this study. No new data was collected. This research was approved by the institutional review boards at both the Kessler Foundation and Montclair State University.

Participants

This study utilized data from 19 individuals with moderate to severe TBI who were enrolled in a treatment study to improve emotional processing deficits following TBI. Participants were recruited at least one year post-injury, with time since injury ranging from 13 to 508 months (*M = 110.32)* as defined by the TBI model systems national database (Harrison-Felix, Newton, Hall, & Kreutzer, 1996). As shown by time since injury, this sample consists of individuals with chronic TBI with an average of nine years since injury. Participants ranged from age 25 to 62 ($M = 44.32$) at baseline evaluation, had between 10 and 17 years of education ($M = 13.74$, $SD = 1.97$), and consisted mostly of males (78.9%). Participants did not have any significant neurological history aside from their brain injuries (e.g. stroke, epilepsy) or a significant substance abuse or psychiatric histories (e.g. schizophrenia, bipolar disorder). This study originally utilized data from 23 participants, but four were dropped from analysis due to missing data in measures relevant to the current study.

Measures

The current study, which was approved by the institutional review boards of both Montclair State University and the Kessler Foundation, examined previously collected and de-identified data taken from the baseline evaluation of an ongoing treatment study at the Kessler Foundation. Data taken from the study consisted of demographic variables such as age, education, and time since injury; FAR and prosody scores taken from the DANVA-2; and quality of life scores taken from the Community Integration Questionnaire (CIQ; Willer, Ottenbacher, & Coad, 1994) and the Quality of Life after Brain Injury questionnaire (QOLIBRI; von Steinbuechel et al., 2012).

DANVA-2. The Diagnostic Analysis of Nonverbal Accuracy 2 is a computerized measure that consists of four subtests: two subtests that examine facial affect recognition and two that examine prosodic recognition. Of these four subtests, two utilize children's faces or voices and two consist of adult faces and voices. Each subtest contains six facial or vocal stimuli (three male, three female) across four different emotions – happiness, sadness, anger, and fear – totaling up to 24 stimuli per subtest.

The FAR subtest consists of one block of 24 trials and utilizes accuracy as the dependent variable to examine deficits in FAR. An image of a male or female person displaying one of the four emotions is shown on a computer screen. Individuals use a mouse to select the emotion they feel most accurately represents the one in the image from the four choices that appear on the screen: i.e. happy, sad, angry, and fearful.

The prosody subtest consists of one block of 24 trials and utilizes accuracy as the dependent variable to examine deficits in prosody. A sound clip of the sentence "I'm going out of the room now, but I'll be back later" is played in each trial in one of four

emotional tones of voice, and a text box is simultaneously displayed containing the sentence on a computer screen. The sound file is played through either computer speakers or headphones. Individuals use a mouse to select the emotion they feel most accurately represents the one in the sound clip from the four choices that appear on the screen: i.e. happy, sad, angry, and fearful (Baum & Nowicki, 1998; Nowicki & Carton, 1993).

DANVA-2 adult faces reliability and validity were examined extensively in prior research (Kaiser & Michael, 1975; Nowicki & Carton, 1993). The DANVA-2 adult prosody reliability and validity were examined extensively in prior research (Baum, Diforio, Tomlinson, & Walker, 1995; Baum & Nowicki, 1998; Nowicki, 1995; Nowicki & Duke, 1983).

Quality of Life. The Community Integration Questionnaire is a 15-item paper-and-pen measure designed to evaluate individual quality of life via assessing social and home integration, levels of involvement in job and school environments, and productive activity (Wilier et al., 1994). Each section of the CIQ includes a number of related items. Home Integration consists of five domestic activity items such as questions about housework, shopping, childcare, etc. (i.e., "Who usually prepares meals in your house?") where individuals indicate their level of involvement in the activity based on several selection options. Social Integration consists of six items that assess leisure and friend-related activities, where individuals must respond with how many times they engage in the activity a month; i.e., "Leisure activities such as movies, sports, restaurants etc." Productive Activity contains one question related to use of transportation; i.e. "How often do you travel outside your home?", while the Job/School Variable section contains three

questions about the amount of hours individuals spend in volunteer, work, and in school activities. Items are scored on a three-point scale, while items related to volunteer, school, and employment activities are scored on a six-point scale. The total score represents a summation of scores from individual questions, which range from zero to 29, where a high score denotes high community integration. CIQ reliability and validity were examined in previous literature (Sander et al., 1999; Wilier et al., 1994; Zhang, Abreu, & Al, 2002).

The Quality of Life after Brain Injury questionnaire is a measure designed to assess health-related quality of life issues specific to clinical TBI populations (QOLIBRI; Steinbüchel, Wilson, Gibbons, Hawthorne, Höfer, Schmidt, Bullinger, Maas, Neugebauer, Powell, Wild, Zitnay, Bakx, Christensen, Koskinen, Formisano, et al., 2010; Steinbüchel, Wilson, Gibbons, Hawthorne, Höfer, Schmidt, Bullinger, Maas, Neugebauer, Powell, Wild, Zitnay, Bakx, Christensen, Koskinen, Sarajuuri, et al., 2010; Steinbüchel et al., 2012; Steinbüchel, Petersen, & Bullinger, 2005). The test consists of 37 items, which measure quality of life via six subscales – every-day functioning (7 items), physical condition (5 items), relationships and social/leisure activity (6 items), cognition (7 items), self (7 items), and feelings/emotions (5 items). Items are rated on a five-point Likert scale ("Not at all/Slightly/Moderately/Very") and consist of either 'bothered items' e.g., "How bothered are you with…"(emotions & physical condition scales) – or 'satisfaction items' – e.g., "How satisfied are you with…"(remaining scales). Additionally, open-ended questions and items that assess item relevance to individual participants are included. QOLIBRI reliability and validity were examined extensively in prior research (Steinbüchel, Wilson, Gibbons, Hawthorne, Höfer, Schmidt, Bullinger,

Maas, Neugebauer, Powell, Wild, Zitnay, Bakx, Christensen, Koskinen, Formisano, et al., 2010; Steinbüchel, Wilson, Gibbons, Hawthorne, Höfer, Schmidt, Bullinger, Maas, Neugebauer, Powell, Wild, Zitnay, Bakx, Christensen, Koskinen, Sarajuuri, et al., 2010).

Procedures

In the original protocol from which the data in this study is drawn, potential participants completed an initial telephone screening compliant with HIPAA regulations, comprised of questions regarding information related to the brain injury, demographics, and medical information. Individuals were randomized into either the control or the treatment group utilizing a computerized random number generator. In order to meet study criteria, participants had to be at least 1 year post-injury, right-handed, and between the ages of 18-65 to control for the effects of aging and development on the brain. Participants were excluded if they had a significant neurological history aside from brain injury (e.g. epilepsy, MS) or significant substance abuse or psychiatric histories (e.g. schizophrenia, bipolar disorder). Participants who met study criteria then underwent a baseline evaluation. After conclusion of the treatment or placebo sessions, participants completed the follow-up assessment. The Baseline Evaluation was comprised of a behavioral assessment consisting of four components. **1.)** Emotional Processing Assessment focused on the ability to recognize and distinguish different emotions. **2.)** Psychological Assessment focused on mood (i.e., depression, anxiety). Measures with forms designed to be completed by significant others were also completed to provide a more objective evaluation of emotional functioning. **3.)** Neuropsychological Assessment consisted of measures of executive functioning, processing speed, and attention. Measures were administered according to standard administration and in a specified and

consistent order. If a participant was unable to complete testing during one session, the assessment was divided into either (1) a morning and an afternoon session or (2) over two days. **4.)** Functional Assessment examined social functioning, quality of life, and functional abilities. Measures with forms designed to be completed by significant others were also completed to provide a more objective evaluation of functioning.

After baseline assessment, all participants received 12 sessions of treatment or 12 sessions of the control conditions. Participants then completed a follow-up evaluation consisting of all measures administered in the Baseline Assessment, using alternate forms wherever available to minimize potential practice effects. For the purposes of this proposal, data from the Baseline Assessment will be utilized.

Statistical Analyses

SPSS (IBM Corp, 2011) was used to conduct all analyses. A descriptive analysis was conducted to evaluate overall performance of individuals with TBI. The means and standard deviations were calculated for FAR and prosody average total accuracy scores, and for total average accuracy scores for individual emotions within FAR and prosody (i.e. happy, sad, angry, fearful). The first hypothesis was that demographics will be correlated with performance on FAR and prosody tasks in individuals with moderate-to-severe TBI. Five bivariate correlations were conducted to test this using age, years of education, months since injury, FAR total average correct, and prosody total average correct as variables. The second hypothesis was that performance on FAR and prosody tasks will be positively correlated in a sample of individuals with moderate-severe TBI. Five bivariate correlations were conducted to test this: FAR total average correct with prosody total average correct, FAR happy total average correct with prosody happy total

average correct, FAR sad total average correct with prosody sad total average correct, FAR angry total average correct with prosody angry total average correct, and FAR fearful total average correct with prosody fearful total average correct. The third hypothesis was that FAR and prosody deficits will correlate with quality of life in individuals with TBI. Four bivariate correlations were conducted to test this using FAR total average correct, prosody total average correct, CIQ total scores, and QOLIBRI total scores as variables. Correction for multiple comparisons was done for all correlations using the Bonferroni method. Paired-sample t-tests were conducted to test for significant differences between means of all relevant variables within groups.

Results

Descriptive Analysis

A frequency analysis of the descriptive statistics was conducted to investigate the percentage of total correct responses for FAR and prosody, as well as correct responses for each emotion within these tasks. On average, individuals with TBI correctly responded to 67% of the 24 total FAR stimuli (M = .67, SD = .15) and 59% of prosody stimuli (M = .59, SD = .12). For individual emotions within FAR, people with TBI correctly responded to 88% of happy faces (M = .88, SD = .19); to 65% of fearful faces (M = .65, SD = .20); to 61% of sad faces (M = .61, SD = .24); and to 51% of angry faces (M = .51, SD = .29). For individual emotions within prosody, people with TBI correctly responded to 61% of happy voices (M = .61, SD = .21); to 53% of fearful voices (M = .53, SD = .22); to 65% of sad voices (M = .65, SD = .22); and 58% of angry voices (M = .58, SD = .24). The range of accuracy for FAR (51% - 88%) and prosody (53% - 65%) scores is lower than accuracy for FAR (93%) and prosody (90%) reported in normative prior normative studies (Nowicki, 2008; Nowicki & Carton, 1993; Nowicki & Duke, 1994).

Correlations

Bivariate Pearson Product Moment correlations were conducted to examine the direction of relationships between total FAR and prosodic emotional deficit variables, participant demographics, and quality of life variables. Tests of the all three hypotheses were conducted using Bonferroni adjusted alpha levels of .01 per test, to correct for multiple comparisons.

The first prediction of this study was that years of education, months since injury, and age would correlated with performance on FAR and prosody tasks in individuals with moderate-to-severe TBI. Five correlations were conducted to test this prediction. Findings indicated a strong positive relationship between years of education and prosody deficits, $r(19) = .69, p < .001$, as shown in Figure 1. However, no relationship was found between years of education and FAR deficits, $r(19) = .40, p = .09$. No relationships were found between the participant's age and the average total average correct scores for FAR, $r(19) = -.10, p = .69$; or for prosody, $r(19) = -.13, p = .60$. Additionally, results showed no correlations between months since injury and average total correct scores for FAR, $r(19) = -.47, p = .04$; or for prosody, $r(19) = -.48, p = .04$.

The second prediction of this study was that FAR and prosody deficits would positively correlate together in individuals with TBI. Five correlations were conducted to test this prediction. Findings indicated there was no relationship between FAR and prosody deficits, $r(19) = .46, p = .05$, as shown in Figure 2. Because total average scores in FAR and prosody did not correlate, the current study did not examine correlations between each individual emotion within FAR and prosody.

The third prediction this study made was that individuals with FAR and prosody deficits would show a decrease in quality of life. Four correlations were conducted to test this prediction. Findings indicated there were no relationships between the CIQ total scores and the average total correct scores for FAR, $r(19) = .23, p = .34$; or for prosody, $r(19) = .30, p = .20$. Similarly, findings indicated no relationships between the QOLIBRI totals scores and FAR, $r(19) = -.04, p = .88$; or prosody, $r(19) = -.12, p = .64$.

T-Tests

A paired-samples t-test was conducted to compare average years of education to average total scores in the prosody tasks. There was a significant difference between years of education ($M = .76$, $SD = .11$) and prosody task ($M = .59$, $SD = .12$) averages; $t(18) =$, $p < .001$, $d = 1.9$, as shown in Table 1.

A paired-samples t-test was conducted to compare the average total correct scores in FAR and prosody tasks. There was a significant difference in the scores for the FAR ($M = .67$, $SD = .15$) and prosody ($M = .59$, $SD = .12$) tasks; $t(18) = 2.24$, $p = .038$, $d = .53$, as shown in Table 1.

Discussion

The current study sought to characterize FAR and prosody deficits in a clinical sample of individuals with moderate-to-severe TBI by examining their FAR and prosody deficits in relation to one another, to the participant demographics, and to their quality of life. This study showed that participants with TBI had difficulty recognizing both facial and prosodic emotions, accurately identifying 67% of faces and 59% of voices, as illustrated in Figure 3. Participants in the current study showed decreased performance in FAR and prosody when compared to DANVA-2 results obtained by Spell & Frank (2000) in a younger TBI sample, as illustrated in Figure 4, and normative data for the DANVA-2 (Nowicki, 2008; Nowicki & Carton, 1993; Nowicki & Duke, 1994).

The first hypothesis is partially supported as results found a strong significant relationship between the number of years of education and prosody deficits in individuals with TBI, as shown in Figure 1. This suggests that participants with higher levels of education have less difficult identifying vocal emotions. However, results indicate that there is no relationship between years of education and FAR deficits. This highlights

differences between deficits in FAR and prosody by showing that these forms of emotional processing may resist brain injury in different ways. Future research should examine prosody deficits in the context of education, as these results suggest that education may fortify emotional processing as a form of cognitive reserve after brain injury, or that extensive exposure to social situations associated with receiving an education improve prosody deficits. These findings have clinical application, as they provide instruction on which demographics within clinical TBI populations require more focused interventions to improve rehabilitation efforts.

Contrary to our second hypothesis, the current study found significant differences between FAR and prosody deficits in individuals with TBI, but no relationship between the two forms of deficits. These findings are inconsistent with prior research, which indicates that individuals with moderate-to-severe TBI who display deficits in their ability to identify the facial emotions of others are more likely to display difficulty in identifying the vocal emotions of others as well (Harciarek et al., 2006; Hornak et al., 1996; Zupan et al., 2009). These results suggest that FAR and prosody deficits significantly differ from one another, where individuals with TBI have more difficult identifying emotions in voices than they do emotions in faces. This difference between FAR and prosody deficits is clinically important because it informs rehabilitation efforts. By showing that these deficits are not related, it demonstrates that interventions designed to improved FAR deficits in clinical TBI populations will not improve deficits in prosody.

Additionally, a descriptive analysis shows both similarities and contrasts between FAR and prosody deficits, as shown in Figure 3. Similarities between deficits are shown

between sad faces and voices, and angry faces and voices. The contrasts stem from the large differences in accuracy shown when identifying happy faces, to the extent that participant's ability to identify happy faces could be characterized as only mildly impaired, while identification of happy voices was at near chance levels. These findings are consistent with prior research indicating that individuals with TBI have more difficulty identifying negative emotions in faces (Spell & Frank, 2000). These findings are also consistent with findings across previous research indicating that individuals with TBI that demonstrate prosody deficits are not specifically worse at identifying either positive or negative emotions, as shown in Figure 5 (Dimoska et al., 2010; Pell, 1998; Spell & Frank, 2000; Zupan & Neumann, 2014).

Contrary to the third prediction, overall prosody deficits did not relate significantly with either of the two quality of life measures examined in the current study, but overall FAR deficits did positively trend near significance with scores from the CIQ, suggesting that additional participant data might yield significance. The findings of our third hypothesis were not consistent with previous research, which indicated the ability to form and maintain social relationships is impaired by the FAR and prosody deficits demonstrated in clinical TBI populations, reducing their overall quality of life (Babbage et al., 2011; Calder & Young, 2005; Radice-Neumann et al., 2007; Schmidt et al., 2010; Zupan et al., 2009). However, the lack of significance between emotional processing deficits and quality of life might be explained by the validity of questions in the CIQ and QOLIBRI to emotional processing in social engagements.

As shown in the appendix, the CIQ is broken down into five subsections: home integration, social integration, productivity, and job/school variables. The home

integration section focuses less on emotions or quality of social involvement with the family, and more on levels of participation and activity around the house, with questions like 'Who usually does the shopping for groceries or other necessities in your household', or 'Who usually prepares meals in your household'. The social integration section has a number of questions that touch on social engagement, such as 'When you participate in leisure activities do you usually do this alone or with others', but also has questions unrelated to socializing such as 'Who usually looks after your personal finances, such as banking or paying bills'. The productivity section consists of only one question regarding how often the individual travels outside the home, focusing primarily on how often an action occurs rather than socialization involve in that action. The job/school variable section consists of two questions asking about level of involvement in work or education (i.e., full-time, part time, etc.) with a third question asking about how frequently they engaged in volunteer activities. While the CIQ is shown as a consistent and valid measure of quality of life, its heavy emphasis on activity makes it insensitive to emotional aspects of quality of life specific to individuals with TBI.

The QOLIBRI showed even less of a relationship with FAR or prosody deficits than the CIQ, which is interesting considering the QOLIBRI was designed specifically to measure quality of life in individuals with TBI. As shown in the appendix, questions in most sections of the QOLIBRI focus heavily on physical activity levels rather than quality of social engagements. The 'self' and 'emotion' subsections are the only parts of the QOLIBRI that focus on emotions rather than activity, but these questions focus on the individual's own emotions rather than recognition of the emotions of others. Only the question asking about feelings of loneliness even in the presence of others addresses

emotions in relation to other people, but this is without reference to other person or their emotions. While the single question within that subsection represents a question that is relevant to the current study via both emotions and quality of life, that one question is the only one that might correlate with any emotional deficit. In the case of the QOLIBRI, while this measure has been shown as a consistent and valid measure of quality of life in TBI populations, the current study cannot be certain that the measure is sensitive enough accurately quantify or qualify the specific socio-emotional aspects of quality of life that the current study seeks to examine.

The present study had some notable limitations. First, the results found by the current study were limited by the lack of research examining relationships between FAR and prosody deficits present in individuals with TBI, particularly ones utilizing the DANVA-2. This lack of previous research presents an opportunity for future researchers to conduct studies to expand our understanding of the nature of the relationships – or lack thereof – between FAR and prosody in individuals with TBI. Second, the current study utilized previously collected data from an ongoing study, which-limited us to a small sample size, since additional participants could not be recruited for the secondary analysis study. This limitation could explain the lack significance of our results, restricting our ability to state that the sample size was conclusively representative of individuals with TBI. A larger data pool might show relationships between overall or individual emotional FAR and prosody deficits that the current study did not find. Future studies should employ larger sample sizes to examine the relationships between these emotional processing deficits.

Third, the research that the current study is based on did not take less severe forms of TBI into consideration when examining the effects of FAR and prosody deficits. While the collected data may representative the lack of relationship between FAR and prosody deficits in individuals with moderate to severe TBI, it is possible that individuals with less severe TBI may show other differences in FAR and prosody deficits. Such differences might effect quality of life in an unforeseen way. Fourth, the current study is limited in that the DANVA-2 utilized in the original study utilizes only four out of the six emotions commonly examined in emotional research: happiness, sadness, anger, and fear. As such, this study is unable to generalize its findings to the 'disgust' and 'surprise' emotions, and cannot infer a relationship between FAR and prosodic deficits in those emotional areas. Future research should utilize a measure designed to examine clinical TBI FAR and prosody deficits in all six emotions, so that deficit levels can be examined and relationships in those emotions within FAR and prosody can be explored.

Fifth, the number of FAR and prosodic stimuli that the DANVA-2 utilizes limits the accuracy of the current study. While the respective 24 facial and prosodic emotional stimuli enabled us to get a clearer picture into the deficits present in clinical TBI populations, future studies would benefit from utilizing a measure with a larger number of facial and prosodic stimuli for each of the six emotions. Sixth, a limitation in the current study utilizes self-report measures in the form of the CIQ and QOLIBRI. Self-report measures are difficult to verify, as they require the assumption that individuals responded to the questionnaire fully and honestly, which can be difficult when the measure asks questions about topics people might answer in a way to make themselves look better to others. Future researchers might utilize different measures that rely less on

self-report measures, or may instead use quality of life measures that comparatively examine both the participants and their significant other's perceptions of the participant.

Finally, the current study is limited in its ability to examine the relationship between emotional processing deficits in clinical TBI populations and quality of life by the overall relevancy of questions within the CIQ and QOLIBRI toward quality of emotions and social engagement. Both of the aforementioned questionnaires focus largely on either activity levels or internal emotions and cognitions, rather than the perceived quality of relationships or interactions with others. Future researchers might utilize or design a measure better equipped to examine quality of life in relation to emotional processing deficits in clinical TBI populations.

The results and limitations of the current study provide many avenues to approach refinement and replication, as well as numerous questions for future research to explore. Future research should examine the effect education has on prosody deficits, as these findings strongly suggest that education may help prosodic capability in individuals with TBI. This study postulates that reduced deficits demonstrated by highly educated individuals with TBI may represent a form of emotional cognitive reserve that has not been explored in the literature. Future studies should seek to examine prosodic deficits in larger samples of TBI individuals with highly varied levels of education to explore their retention of prosodic abilities further. Additionally, future research should conduct a longitudinal study that examines individuals with TBI who are currently enrolled in educational institutions to actively examine whether prosodic abilities increase in these individuals as they complete higher levels of education.

Future research should seek to examine the relationships shown in the study with a larger clinical TBI sample, as the results will be more broadly generalizable to clinical TBI populations. Additionally, correlations such as FAR and prosody may reach significance in larger sample sizes. Such findings, if shown, would serve to instruct clinicians by allowing them to improve deficits in both FAR and prosody by using interventions designed to improve either form of deficit.

Future research should also examine these findings in the context of intervention, to further understand whether a relationship between FAR and prosody deficits exists. The current study's findings indicate that these two emotional processing deficits are not linked; implying that clinical efforts and interventions designed to improve FAR deficits will not improve prosody deficits in individuals that demonstrate deficits in both forms of emotional processing deficits. The current study's limited sample size may have contributed to this lack of significance, indicating that future research should still examine whether a relationship between FAR and prosody deficits exists. To further the body of literature and our understanding of these differences, future research should examine whether interventions designed to improve either deficit has an effect on the other deficit. First, the relationship between FAR and prosody deficits should be examined both before and after different interventions are employed. Such studies should examine whether interventions designed to improve FAR will have an effect on prosodic deficits, and vice versa. These studies should focus on whether FAR and prosody deficits correlate to one another both before and after intervention, how much each deficit is reduced by, and whether reductions in either emotional processing deficit are greater, lesser, or equal to one another.

Future studies should also develop and utilize quality of life measures that are more sensitive to the socio-emotional aspects of quality of life, allowing future research to create a better picture of the relationship between the emotional processing deficits demonstrated by clinical TBI populations, and the effect they have on their quality of life. Measures such as the QOLIBRI and CIQ could be used to indicate their level of social activity before administering an emotional quality of life measure specifically focused on emotional processing in a social context.

The findings of the current study contribute significantly to the body of literature on the subject of TBI, providing important implications toward clinical application in future clinical TBI emotional processing rehabilitation efforts. While some of our predictions have not been shown at analysis, these findings act as an important foundation for the expansion of future research, and show promising results toward improving the lives of all individuals effected by TBI.

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Table 1

T-Test Results for FAR with Prosody, and Average Years of Education with Prosody

Group	*M*	*SD*	*t*(19)	*p*	95% CI		Cohen's *d*
					LL	*UL*	
Avg. Years of Ed. - Prosody	0.17211	0.09023	8.314	0.001	0.12861	0.2156	1.9
FAR - Prosody	0.07421	0.14416	2.244	0.038	0.00473	0.14369	0.53

Note. *M* = Mean; *SD* = Standard Deviation; *CI* = Confidence Interval; *LL* = Lower Limit; *UL* = Upper Limit; Avg. = Average; Ed. = Education; FAR = Facial Affect Recognition.

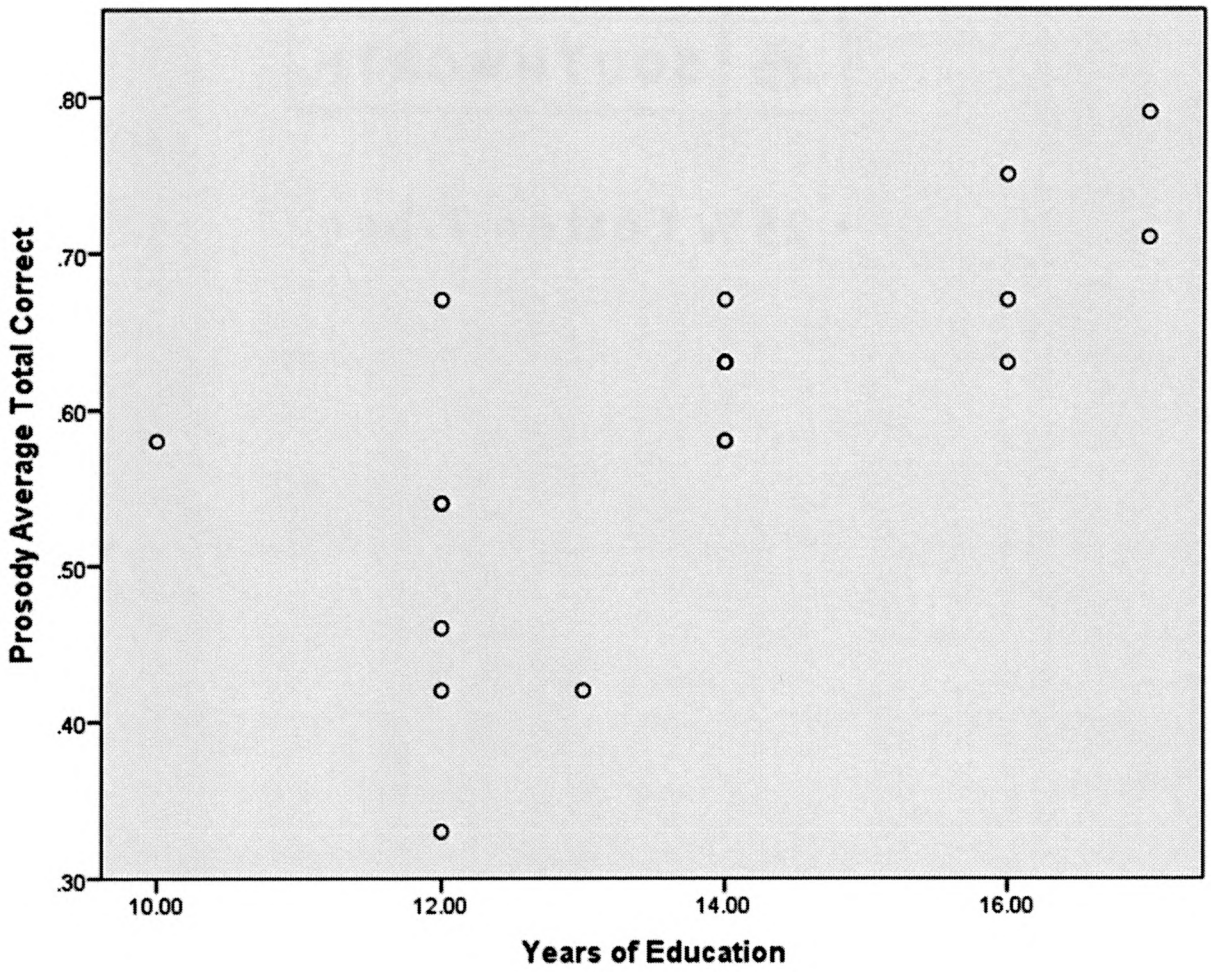

Figure 1. Relationship between average total scores on the prosody task and number of years of education. Pearson's $r = .69$.

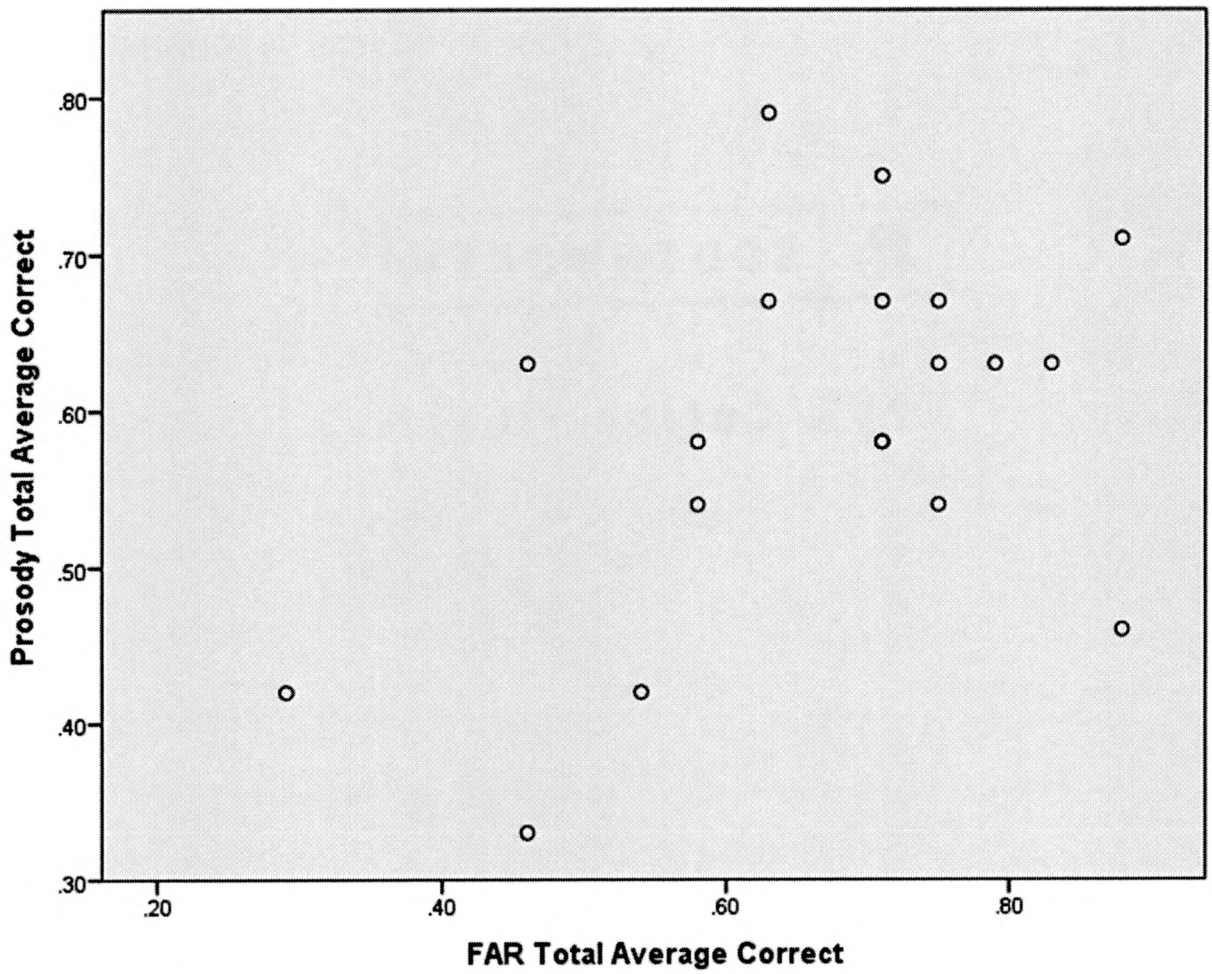

Figure 2. Relationship between average total scores on the FAR and prosody tasks. Pearson's $r = .69$. FAR = Facial Affect Recognition.

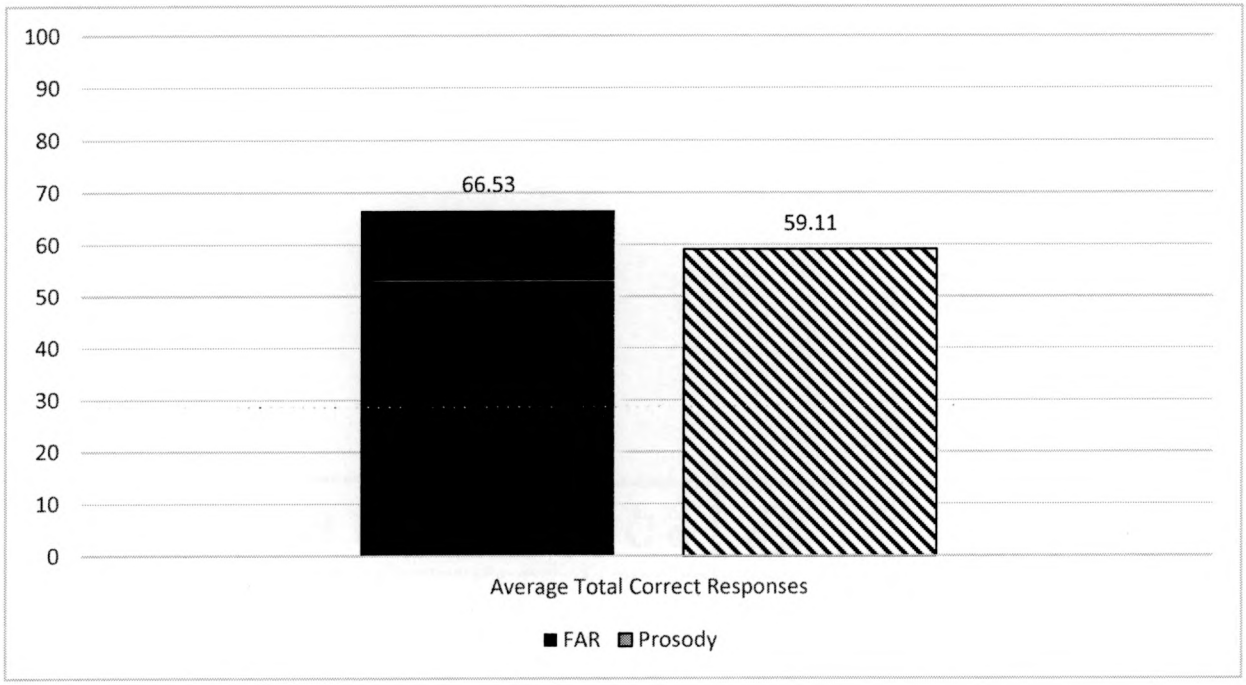

Figure 3. FAR and Prosody Average Total Correct Responses. FAR = Facial Affect Recognition.

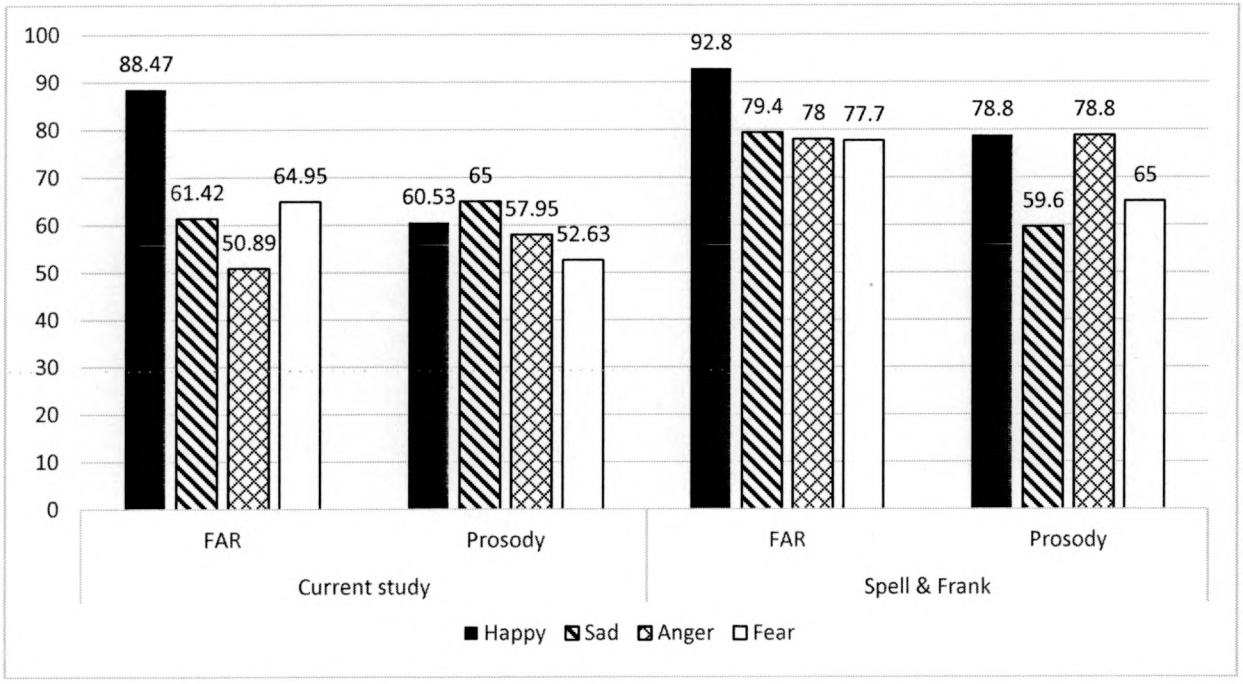

Figure 4. Visual Comparison of Individual Emotion Scores in FAR and Prosody for the Current Study and Spell & Frank (2000). FAR = Facial Affect Recognition.

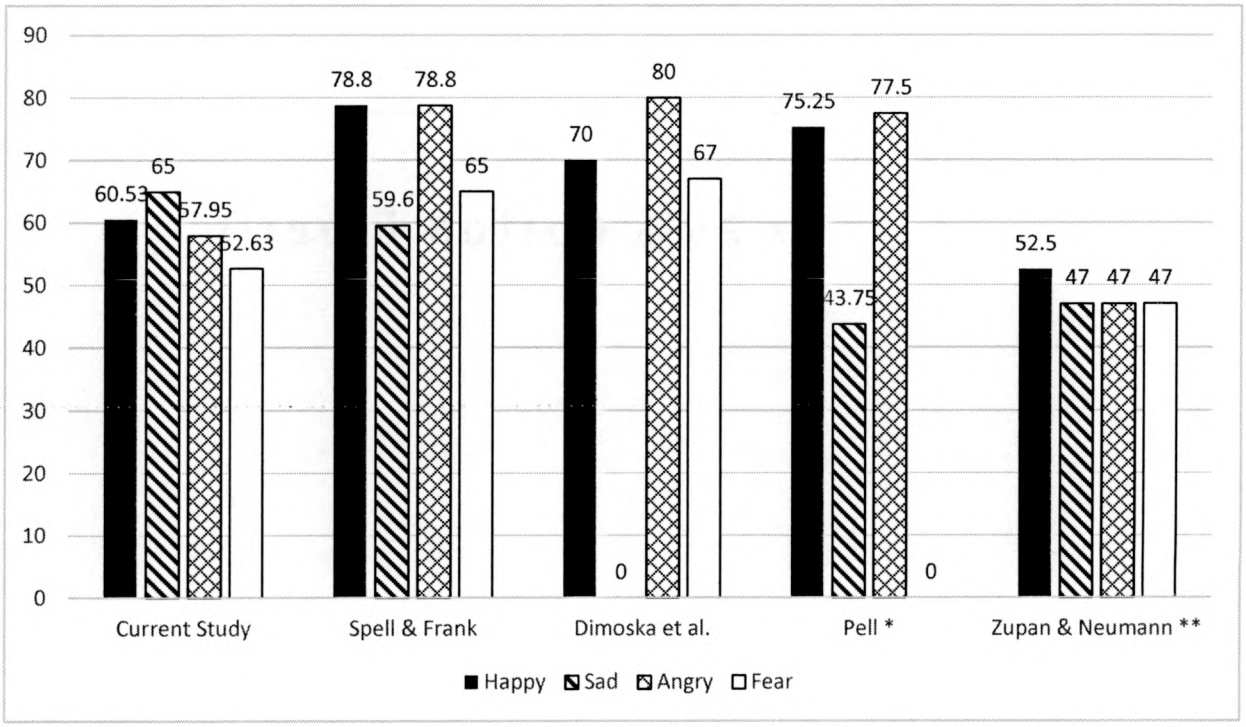

Figure 5. Visual Comparison of Individual Emotion Scores in Prosody for the Current Study, Spell & Frank, Dimoska et al., Pell, and Zupan & Neumann (Dimoska et al., 2010; Pell, 1998; Spell & Frank, 2000; Zupan & Neumann, 2014). Mean accuracy from Pell was averaged from left and right hemisphere damage group scores (Pell, 1998). Zupan & Neumann combined the mean accuracy for all negative emotions into one score (Zupan & Neumann, 2014).

Appendix

AN ANALYSIS OF NON-VERBAL EMOTION RECOGNITION IN INDIVIDUALS WITH TRAUMATIC BRAIN INJURY

Enclosed:

Community Integration Questionnaire (CIQ)

CIQ Scoring Syllabus

Quality of Life after Brain Injury (QOLIBRI)

QOLIBRI Scoring Instructions

COMMUNITY INTEGRATION QUESTIONNAIRE

Subject: _____ **Date:** _____

1. Who usually does the shopping for groceries or other necessities in your household?	○ Yourself alone ○ Yourself and someone else ○ Someone else
2. Who usually prepares meals in your household?	○ Yourself alone ○ Yourself and someone else ○ Someone else
3. In your home who usually does the everyday housework?	○ Yourself alone ○ Yourself and someone else ○ Someone else
4. Who usually cares for the children in your home?	○ Yourself alone ○ Yourself and someone else ○ Someone else ○ Not applicable, No children under 17 in the home
5. Who usually plans social arrangements such as get-togethers with family and friends?	○ Yourself alone ○ Yourself and someone else ○ Someone else
6. Who usually looks after your personal finances, such as banking or paying bills?	○ Yourself alone ○ Yourself and someone else ○ Someone else
7. Approximately how many times a month do you usually participate in shopping *outside* your home?	○ Never ○ 1 - 4 times ○ 5 or more
8. Approximately how many times a month do you usually participate in leisure activities such as movies, sports, restaurants, etc.	○ Never ○ 1 - 4 times ○ 5 or more
9. Approximately how many times a month do you usually visit your friends or relatives?	○ Never ○ 1 - 4 times ○ 5 or more
10. When you participate in leisure activities do you usually do this alone or with others?	○ Mostly alone ○ Mostly with friends who have head injuries ○ Mostly with family members ○ Mostly with friends who do not have head injuries ○ With a combination of family and friends

Please complete page two

COMMUNITY INTEGRATION QUESTIONNAIRE (Page 2)

11. Do you have a best friend with whom you confide?	○ Yes ○ No
12. How often do you travel outside the home?	○ Almost every day ○ Almost every week ○ Seldom/never (less than once per week)
13. Please choose the answer that best corresponds to your current (during the past month) work situation:	○ Full-time (more than 20 hours/week) ○ Part-time (less than or equal to 20 hrs/week) ○ Not working, but actively looking for work ○ Not working, not looking for work ○ Not applicable, retired due to age
14. Please choose the answer that best corresponds to your current (during the past month) school or training program situation:	○ Full-time ○ Part-time ○ Not attending school, or training program ○ Not applicable, retired due to age
15. In the past month, how often did you engage in volunteer activities?	○ Never ○ 1 - 4 times ○ 5 or more

Comments:

CIQ SYLLABUS

Home Integration Section

1. Who usually does shopping for groceries or other necessities in your household?

Answer	Score
yourself alone	2
yourself and someone else	1
someone else	0

2. Who usually prepares meals in your household?

Answer	Score
yourself alone	2
yourself and someone else	1
someone else	0

3. In your home who usually does normal everyday housework?

Answer	Score
yourself alone	2
yourself and someone else	1
someone else	0

4. Who usually cares for the children in your home?

Answer	Score
yourself alone	2
yourself and someone else	1

someone else	0
not applicable/ no children under 17 in the home	*

* score is average of items 1, 2, 3, and 5

5. Who usually plans social arrangements such as get-togethers with family and friends?

Answer	Score
yourself alone	2
yourself and someone else	1
someone else	0

HOME INTEGRATION SCORE = (sum of items 1 through 5)

Social Integration Section

6. Who usually looks after your personal finances, such as banking or paying bills?

Answer	Score
yourself alone	2
yourself and someone else	1
someone else	0

Questions 7-9: Can you tell me approximately how many times a month you now usually participate in the following activities ou

7. Shopping

Answer	Score
5 or more	2
1-4 times	1
Never	0

8. Leisure activities such as movies, sports, restaurants, etc.

Answer	Score
5 or more	2
1-4 times	1

Never	0

9. Visiting friends or relatives

Answer	Score
5 or more	2
1-4 times	1
Never	0

10. When you participate in leisure activities do you usually do this alone or with others?

Answer	Score
mostly alone	0
mostly with friends who have head injuries	1
mostly with family members	1
mostly with friends who do not have head injuries	2
with a combination of family and friends	2

11. Do you have a best friend with whom you confide?

Answer	Score
yes	2
no	0

SOCIAL INTEGRATION SCORE = (sum of items 6 through 11)

Productivity Section

12. How often do you travel outside the home?

Answer	Score
almost every day	2
almost every week	1
seldom/never (less than once per week)	0

JOBSCHOOL VARIABLE: (items 13 to 15):
These items, although collected individually, will be combined to form one variable, Jobschool.

13. Please check the answer below that best corresponds to your current (during the past month) work situation:

Answer
full-time (> 20 hours per week)
part-time (≤ to 20 hours per wk)
not working, but actively looking for work
not working, not looking for work
not applicable, retired due to age

14. Please check the answer below that best corresponds to your current (during the past month) school or training program situation:

Answer
full-time
part-time
not attending school or training program
not applicable, retired due to age

15. In the past month, how often did you engage in volunteer activities?

Answer
5 or more
1-4 times
never

JOBSCHOOL VARIABLE SCORING (items 13 to 15):

These items, although collected individually, will be combined to form one variable, Jobschool.

For the Jobschool variable, the following scoring system will appl

JOBSCHOOL	Score
Not working, not looking for work, not going to school, no volunteer activities	0
Volunteers 1 to 4 times a month AND not working, not looking for work, not in school	1
Actively looking for work AND/OR volunteers 5 or more times per month	2
Attends school part-time OR working part-time (less than 20 hours per week)	3
Attends school full-time OR works full-time	4
Works full-time AND attends school part-time OR Attends school full-time AND works part-time (less than 20 hours per week)	5

If Retired due to Age, the JOBSCHOOL variable is based on item 15 (Volunteer Activities) only

IF RETIRED, SCORE AS:

In the past month, how often did you engage in volunteer activities?

Answer	Score
5 or more	4
1-4 times	2
Never	0

PRODUCTIVITY SCORE = (sum of item 12 and the Jobschool variable)

TOTAL CIQ SCORE

= HOME INTEGRATION SCORE+SOCIAL INTEGRATION SC(

range = 0 to 29 (maximum community integration)

PROVIDENCE
Health & Services

QOLIBRI - QUALITY OF LIFE AFTER BRAIN INJURY

In the first part of this questionnaire we would like to know **how satisfied** you are with different aspects of your life since your brain injury. For each question please choose the answer which is closest to how you feel now (including the past week) and mark the box with an "X". If you have problems filling out the questionnaire, please ask for help.

PART 1

A. These questions are about your thinking abilities now (including the past week).

	Not at all	Slightly	Moderately	Quite	Very
1. How satisfied are you with your ability to concentrate, for example when reading or keeping track of a conversation?					
2. How satisfied are you with your ability to express yourself and understand others in a conversation?					
3. How satisfied are you with your ability to remember everyday things, for example where you have put things?					
4. How satisfied are you with your ability to plan and work out solutions to everyday practical problems, for example what to do when you lose your keys?					
5. How satisfied are you with your ability to make decisions?					
6. How satisfied are you with your ability to find your way around?					
7. How satisfied are you with your speed of thinking?					

B. These questions are about your emotions and view of yourself now (including the past week).

	Not at all	Slightly	Moderately	Quite	Very
1. How satisfied are you with your level of energy?					
2. How satisfied are you with your level of motivation to do things?					
3. How satisfied are you with your self-esteem, how valuable you feel?					
4. How satisfied are you with the way you look?					
5. How satisfied are you with what you have achieved since your brain injury?					
6. How satisfied are you with the way you perceive yourself?					
7. How satisfied are you with the way you see your future?					

C. These questions are about your independence and how you function in daily life now (including the past week).

	Not at all	Slightly	Moderately	Quite	Very
1. How satisfied are you with the extent of your independence from others?					
2. How satisfied are you with your ability to get out and about?					
3. How satisfied are you with your ability to carry out domestic activities, for example cooking or repairing things?					
4. How satisfied are you with your ability to run your personal finances?					
5. How satisfied are you with your participation in work or education?					
6. How satisfied are you with your participation in social and leisure activities, for example sports, hobbies, parties?					
7. How satisfied are you with the extent to which you are in charge of your own life?					

D. These questions are about your social relationships now (including the past week)

	Not at all	Slightly	Moderately	Quite	Very
1. How satisfied are you with your ability to feel affection towards others, for example your partner, family, friends?					
2. How satisfied are you with your relationships with members of your family?					
3. How satisfied are you with your relationships with your friends?					
4. How satisfied are you with your relationship with a partner or with not having a partner?					
5. How satisfied are you with your sex life?					
6. How satisfied are you with the attitudes of other people towards you?					

PART 2

In the second part we would like to know **how bothered** you feel by different problems. For each question please choose the answer which is closest to how you feel now (including the past week) and mark the box with an "X". If you have problems filling out the questionnaire, please ask for help.

E. These questions are about how bothered you are by your feelings now (including the past week).

	Not at all	Slightly	Moderately	Quite	Very
1. How bothered are you by feeling lonely, even when you are with other people?					
2. How bothered are you by feeling bored?					
3. How bothered are you by feeling anxious?					
4. How bothered are you by feeling sad or depressed?					
5. How bothered are you by feeling angry or aggressive?					

F. These questions are about how bothered you are by physical problems now (including the past week).

	Not at all	Slightly	Moderately	Quite	Very
1. How bothered are you by slowness and/or clumsiness of movement?					
2. How bothered are you by effects of any other injuries you sustained at the same time as your brain injury?					
3. How bothered are you by pain, including headaches?					
4. How bothered are you by problems with seeing or hearing?					
5. Overall, how bothered are you by the effects of your brain injury?					

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Scoring

The QOLIBRI scores are reported on a 0-100 scale , where 0=worst possible quality of life and 100=best possible quality of life.

Calculating scale scores:-

Responses to the 'satisfaction' items (i.e. items on the Cognition, Self, Daily Life & Autonomy, and Social Relationships scales) are coded on a 1 to 5 scale, where 1= "not at all satisfied" and 5="very satisfied". Responses to the 'bothered' items (i.e. items on the Emotions and Physical Problems scales) are reverse scored to correspond with the satisfaction items, where 1="very bothered" and 5="not at all bothered".

The responses on each scale are summed to give a total, and then divided by the number of responses to give a scale mean. The scale means have a maximum possible range of 1 to 5. The mean can be computed when there are some missing responses, but should not be calculated if more than one third of responses on the scale are missing. In a similar manner the QOLIBRI Total score is calculated by summing all the responses, and then dividing by the actual number of responses. Again, a total score should not be calculated if more than one third of responses are missing.

The scale means are converted to the 0-100 scale by subtracting 1 from the mean and then multiplying by 25. This produces scale scores which have a lowest possible value of 0 (worst possible quality of life) and a maximum value of 100 (best possible quality of life).

Sample PASW/SPSS syntax.

```
*** Means for QOLIBRI scales ****.
compute qcog= mean.5 (qa1 to qa7 ).
compute qself = mean.5 (qb1 to qb7 ).
compute qadl = mean.5 (qc1 to qc7 ).
compute qsoc = mean.4 (qd1 to qd6 ).
compute qemo = mean.4 (qe1 to qe5 ).
compute qphys = mean.4 (qf1 to qf5).
Compute qtot = mean.25(qa1 to qf5).
formats qcogn to qtot (f4.2).
exe.
*** Scores for QOL scales ****.
do repeat mean = qcog to qtot /
perc = pqcog pqself pqadl pqsoc pqemo pqphys pqtot.
compute perc = (mean - 1) * 25 .
formats perc (f5.1).
end repeat print.
exe
```