Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

Affect Recognition Training After Traumatic Brain Injury

A thesis submitted in partial fulfilment of the requirements for the Degree of Doctor of Clinical Psychology at Massey University, Wellington, New Zealand

Jackki Yim Hoon Eng

2013

Abstract

Impairment in facial affect recognition is prevalent after moderate to severe traumatic brain injury (TBI), and may underlie some problems in social functioning. Tentative work indicates that emotion recognition can improve with training, but the effectiveness of these programmes remains unclear. Little is known about whether broader cognitive deficits underlie facial affect recognition impairment. Less is known about baseline cognitive variables that predict treatment response and the relationship between changes in cognitive functioning and improvement in facial affect recognition after treatment. The present research formed part of a multi-centre randomised controlled trial examining the efficacy of two affect recognition training programmes designed to improve emotion recognition in adults with moderate to severe TBI.

Study One reports outcome data from the main trial. Seventy people with TBI and facial affect recognition difficulties were randomly assigned to nine sessions of one of three treatments: *Faces*, focusing on facial affect recognition, *Stories*, determining emotions from social context, and a control group. Participants completed tests assessing cognition, emotion recognition, community integration, interpersonal behaviour and empathy, and informants completed interpersonal and social functioning measures. Participants were assessed five times: initial screening, pre- and post-treatment, and at three- and six-month follow-up. Significant improvement was seen in the *Faces* group on the primary facial affect recognition outcome measure (DANVA2-Adult Faces). These gains were sustained at six months. No significant differences between treatment groups and the control group were found on interpersonal and social functioning measures.

Study Two had 75 participants with facial affect recognition difficulties and investigated the relationship between facial affect recognition impairment and cognitive functioning. Greater facial affect recognition failures were related particularly to working memory, processing speed, and nonverbal memory. No relationship was found with executive functioning.

Study Three explored the relationship between baseline cognitive variables, changes in cognitive functioning, and long term treatment response. Only older age was predictive of a better long-term response to *Face*s treatment. Improvement of facial affect recognition was not mediated by changes in cognitive functioning.

This research provides further evidence that retraining is possible for affect recognition difficulties after traumatic brain injury.

Acknowledgements

This study forms part of an international multi-centre project and has been supported by funding from the US National Institute on Disability and Rehabilitation Research (grant no. H133G080043). The research process over the last three years has been challenging and exhausting but also highly stimulating. I have many people to thank for the help and support they have provided.

Firstly, let me thank all the participants and their families who contributed to this study. I feel privileged that they shared their personal and emotional experiences with me, and I have learned so much from them all.

Secondly, I would like to extend my deepest gratitude and appreciation to my supervisor, Dr Duncan Babbage, for his guidance and brilliance as a teacher, a scientist and a friend. I am grateful to him for his patience, his insight and his direction throughout the dissertation process. He always encouraged me to feel optimistic after every supervision meeting; to Duncan, my heartfelt thanks.

Thirdly, I would like to thank the international team members involved in the project: Professor Barry Willer, Dr Dawn Neumann, and Dr Barbra Zupan. My thanks also to Dr Machiko Tomita and Dr Steve Humphries for statistical guidance and assistance.

Fourthly, I thank Anne-Marie Ngan, Bruce Dunn, Karen Commons, Dr Jason Low and Doreen Lim, who have all provided warm encouragement and displayed a consistent, cheerful willingness to help.

Fifthly, this thesis is dedicated to two special people, one of them is Emily Neo, my friend from childhood whom I will follow everywhere with my love. The other is Rowena who has listened to all my woes throughout. Without her unwavering encouragement, love and support, I could not have finished this project. She has been like a bouncing ball filled with positive energy: to Rowena, my boundless thanks.

Finally, I wish to thank my family, especially my dear old mum. She has waited so patiently while I have been engaged on this doctoral journey; it has been a long haul, and I am looking forward to sharing more “laughing” moments together! A warm thank you also to my nieces and nephews, who love me purely for being ‘Auntie Jackki’!

Preface

This thesis examines the effectiveness of two new interventions that each aimed to enhance emotion-recognition skills in people with traumatic brain injury (TBI). In addition, it addresses the issues regarding the cognitive processes involved in facial affect recognition. It is hoped that this research will stimulate further research in establishing useful evidence-based interventions for optimizing emotion-recognition skills remediation and outcome in individuals with TBI.

A growing number of studies suggest that impairments in facial affect recognition are prevalent in people with moderate to severe traumatic brain injury (D R Babbage et al., 2011; Bornhofen & McDonald, 2008a; McDonald, 2013; C. Williams & Wood, 2010) and that this deficit might well be an important determinant of poor social outcomes (Driscoll, Dal Monte, & Grafman, 2011). This research development has led to the implementation of trials and the evaluation of training programmes that specifically target facial affect-recognition deficits for this clinical group (Bornhofen & McDonald, 2008b, 2008c; Guercio, Podolska-Schroeder, & Rehfeldt, 2004; McDonald, Bornhofen, & Hunt, 2009b; Radice-Neumann, Zupan, Tomita, & Willer, 2009). However, the effectiveness of these programmes and their effects on social outcomes remain unclear. The present research formed part of a multi-centre randomised controlled trial, examining the efficacy of two affect recognition training programmes designed to improve different aspects of emotion recognition in adults with moderate to severe TBI. Study One reported an analysis of outcome data from the main trial. Through using targeted emotion recognition training intervention, retraining is possible for affect recognition difficulties after traumatic brain injury.

The cognitive deficits in TBI are well-documented (Dikmen et al., 2009; Ruttan, Martin, Liu, Colella, & Green, 2008), yet little is known about whether these broader cognitive deficits partly underlie facial affect recognition impairments in this clinical group (Allerdings & Alfano, 2006; Spikman, Timmerman, Milders, Veenstra, & van der Naalt, 2012). Although tentative work has indicated that emotion recognition can improve with training programmes, the effects of cognitive functioning on treatment outcome and the trajectory of such functioning after facial affect treatment have yet to be fully determined. Studies Two and Three begin to address these gaps in the literature by directly exploring the relationship between facial affect recognition impairments and cognitive functioning, and by investigating the baseline cognitive variables, changes in cognitive functioning, and long term treatment response. The relationship between facial affect recognition and cognitive functioning in TBI is complex and multifactorial, and may be influenced by both internal and external factors. A better understanding of the linkage between the two domains and the individual factors that may predict treatment response could better inform research into the identification of more precise therapeutic targets to improve facial affect recognition. These skills are potentially significant in helping people with TBI to lead optimal social lives (Driscoll et al., 2011).

Structure of the Thesis

This thesis is presented in three empirical investigations. Specifically, it investigates the effectiveness of two new training programmes designed to improve different aspects of emotion-recognition skills for people with TBI; examines the relationship between facial affect recognition impairments and cognitive functioning after TBI; explores the baseline cognitive variables and other demographic variables associated with long-term treatment response, and investigates whether improvement in facial affect recognition is related to changes in cognitive functioning. The present research focuses on adults with moderate to severe TBI.

This thesis consists of eleven chapters incorporating three studies, and is submitted with two chapters explicitly presented in publication format. Supporting chapters introduce the studies, and provide discussion of the findings set within them. Chapter One provides a brief introduction of traumatic brain injury and discusses its impact on people's social and interpersonal functioning. Chapter Two provides an overview of facial affect recognition and reviews empirical findings relating to the theoretical models and neural mechanisms behind this domain. Chapters Three and Four outline the empirical knowledge pertaining to facial affect-recognition impairments (including other emotion recognition deficits) after traumatic brain injury, and highlight the need for development of effective treatments to enhance emotion recognition for people with TBI. These first four chapters provide the rationale for this thesis and place it within the current frame of empirical knowledge and theoretical understanding. Chapter Five outlines the range of research questions addressed by the thesis. Chapter Six, Seven, and Eight present the first study, which was conducted to examine the effectiveness of two new affect recognition treatments and their effects on social functioning. Chapter Nine presents the second study, and investigates the relationship between facial affect recognition impairments and cognitive functioning. Chapter Ten presents the final study and explores the baseline cognitive variables and other demographic characteristics associated with long-term treatment response. It also examines whether changes in cognitive functioning mediate the effects of treatment outcomes. Finally, Chapter Eleven provides an overall summary and conclusion of the research findings of the thesis.

Authorship and Contributions

This research was part of a larger international study investigating the efficacy of two affect-recognition training interventions. While the main idea for this wider project was not mine, I was involved in the Ethics application to the Central Regional Health Disability, in the recruitment of participants, and in the provision of treatment to the New Zealand sample. Study one presents an analysis of the main outcome data from this trial, across the three sites. I carried out this analysis of the data (drawn from all three sites) relating to the effectiveness or otherwise of the two interventions independently of the wider research team, though with their full support. The analysis of these wider outcomes presented in this first study thus represents my own work, with only the usual doctoral supervisory input. Alongside this, I took sole responsibility for leading the investigations of the relationship between cognitive variables and the outcomes of the trial within the wider research team. The original aspects of the investigation underpinning the other two studies in this thesis related to this were thus entirely mine.

My supervisor, Dr Duncan Babbage, has trained me how to structure my arguments, has provided statistical advice, has provided critical review of my articles, and has discussed selection of appropriate journals for publication of material. For these reasons he will be named as co-author for the publications included in this thesis. Professor Barry Willer, the lead investigator for this project, along with Dr Dawn Neumann and Dr Barbra Zupan, the principal investigators at the Canadian and United States of America sites, will also be included as co-authors for the publications.

Presented after each chapter that is formatted as a paper for publication is a statement that outlines the contributions of each of the authors to the paper. In all cases for the papers included in this thesis, the input provided by other authors to the version of the paper included in the thesis was only the level of input normally provided by a doctoral supervisor for any thesis chapter.

Table of Contents

Abstract i

Acknowledgements iii

Preface iv

Structure of the Thesis vi

Authorship and Contributions vii

List of Figures xii

List of Tables xiv

Chapter 1: Social Complications Following Traumatic Brain Injury 1

Defining Traumatic Brain Injury and Prevalence 1

How does TBI Influence Psychosocial Functioning? 2

Why Focus on Facial Affect Recognition Skills in TBI? 3

Chapter 2: Facial Affect Recognition 5

What is Facial Affect Recognition? 5

Neuroanatomical Substrates Underlying Processing of Facial Cues 6

Theories of Facial Affect Recognition 9

Chapter 3: Facial Affect Recognition in People with TBI 12

How does TBI Influence Facial Affect Recognition? 12

How does TBI Influence Other Forms of Emotion Recognition? 15

Is There a Link Between Facial Affect Recognition Impairment and Cognitive Dysfunction? 17

Chapter 4: Facial Affect Recognition Training 20

Can Facial Affect Recognition Skills in TBI be Restored? 20

Summary 23

Chapter 5: Rationale and Goals of the Present Research 24

Chapter 6: Study One Methods 28

Design..28

Participants 29

Measures..32

Procedure...37

Planned Statistical Analyses...45

Chapter 7: Study One Results..51

Baseline Differences 51

Attrition 57

Facial Affect Recognition 58

Emotional Inference from Context..63

Empathy 64

Social Functioning...67

Depression 71

Chapter 8: Study One Discussion 73

Conclusion..84

Chapter 9: Study Two...86

Abstract 86

Method 89

Procedure...91

Results 93

Discussion 96

References 101

Chapter 10: Study Three 106

Abstract 106

Method 110

Procedure 112

Results.. 117

Discussion.. 119

References.. 124

Chapter 11: Overall Discussion and Conclusion 129

Research Aims 129

Contributions to the Literature on Emotion Recognition Associated with TBI 130

Implications 132

Limitations.. 134

Future Research 135

Conclusion 138

References.. 140

Appendices.. 165

Appendix A: Screening and Other Outcome Measures.. 165

Appendix B: Description of CogState Measures.. 170

Appendix C: Information Sheet for Participant.. 172

Appendix D: Information Sheet for Participant (Overview) 175

Appendix E: Information Sheet for Family Member.. 177

Appendix F: Consent Form.. 179

Appendix G: Treatment Manual for *Faces* Intervention 180

Appendix H. Treatment Manual for *Stories* Intervention.. 211

Appendix I. Part 1 of the *Faces* Training 231

Appendix J. Part 2 of the *Faces* Training 232

Appendix K. *Stories* Training (Story 1).. 233

Appendix L. Cognitive Training.. 234

List of Figures

Figure 1. Neural correlates of processing facial cues of emotions and other aspects of social cognitive processing 7

Figure 2. Visual depiction of possible pathways of interaction between components of facial affect recognition 11

Figure 3. Summary of the study design........ 28

Figure 4. CONSORT flow diagram of participants through the randomised trial. 54

Figure 5. CONSORT flow diagram of informants through the randomised trial 55

Figure 6. CONSORT flow diagram of participants through randomised trial at the New Zealand site 56

Figure 7. Estimated marginal mean scores at each time point for the DANVA2-Adult Faces total correct responses of the three treatment groups 58

Figure 8. Mean change in z-scores for DANVA2-Adult Faces from baseline to post-test, from baseline to three months, and from baseline to six months according to treatment group 59

Figure 9. Estimated marginal mean scores at each time point for the Facial Affect Naming (subtest 3) of the Florida Affect Battery 62

Figure 10. Mean change in FAB-3 Facial Affect Naming z-scores from baseline to post-test, from baseline to three months, and from baseline to six months for each treatment group 62

Figure 11. EIST total scores in each treatment group at baseline, post-treatment, three- and six-month follow-up of treatment and the change in EIST scores from baseline to each of the three time points 64

Figure 12. IRI total scores for participants and their informants in each treatment group at baseline, post-treatment, three-and six-month follow-up and the change in IRI scores from baseline to each of the three time points by treatment condition 66

Figure 13. Estimated marginal mean scores at each time point for the LISRES-A Stressor of the three treatment groups and the change of baseline for these measures at post-test, three and six months after treatment for participants and informants.. 69

Figure 14. Estimated marginal mean scores at each time point for the LISRES-A Support of the three treatment groups and the change of baseline for these measures at post-test, three and six months after treatment for participants and informants.. 70

Figure 15. Estimated marginal mean scores at each time point for the CIQ of the three treatment groups and the change of baseline for these measures at post-test, three and six months after treatment for participants and informants............ 71

Figure 16. Changes in BDI total scores for each training group and mean changes in BDI total scores from baseline to 3 month follow-up.................................... 72

Figure 17. Raw correlations between facial affect recognition and cognitive variables 94

List of Tables

Table 1. Demographic Information of Participants (N = 70) 31

Table 2. Assessment Procedure 38

Table 3. Percentage of Missing Data by Variable at Each Time Point for Participants . 47

Table 4. Comparison of Participant Characteristics 52

Table 5.One way ANOVA for Comparing Three Treatment Groups on Outcome Measures at Baseline 53

Table 6. One Way ANOVA for Comparing the Informants across the Three Groups on Outcome Measures at Baseline 53

Table 7. Faces and Control Group Mean Scores on Outcome Measures and Repeated Measures ANCOVA Results 60

Table 8. Stories and Control Group Mean Scores on Outcome Measures and Repeated ANOVA Results 61

Table 9. Simple Regression Analysis for Prediction of Facial Affect Recognition Measures by Cognitive Variables 95

Table 10. Demographic and clinical characteristics of treatment responders and non-responders to the *Face*s Treatment 117

Table 11. Correlation between Cognitive Function and Facial Affect Recognition Z-Score Changes and Treatment Group from Baseline to Post-Treatment 119

Chapter 1: Social Complications Following Traumatic Brain Injury

Men ought to know that from the brain, and from the brain only, arise our pleasures, joys, laughter, and jests, as well as our sorrows, pains, griefs and tears. Through it, in particular, we think, see, hear, and distinguish the ugly from the beautiful, the bad from the good, the pleasant from the unpleasant… It is the same thing which makes us mad or delirious, inspires us with dread and fear, whether by night or by day, brings sleeplessness, inopportune mistakes, aimless anxieties, absent mindedness and acts that are contrary to habit?

Hippocrates (as cited in Penfield, 1958, p. 51)

Defining Traumatic Brain Injury and Prevalence

Traumatic brain injury (TBI) is a serious public health problem that affects approximately ten million people annually worldwide (Langlois, Rutland-Brown, & Wald, 2006). As one of the leading causes of death and long-term disability, it affects both young and old (Maas, Stocchetti, & Bullock, 2008). TBI refers to an abrupt application of a direct external force onto the skull and brain causing either a penetrating (open) or non-penetrating (closed) head injury (Crowe, 2008). It is therefore neither degenerative nor congenital (Archer, Svensson, & Alricsson, 2012). In New Zealand, TBI affects approximately 20,000 to 30,000 individuals annually; some 2,000 to 3,000 of these suffer moderate to severe TBI (New Zealand Guidelines Group, 2006). The health cost arising from TBI has been estimated to exceed $100 million each year in this country (New Zealand Guidelines Group, 2006). According to Crowe (2008), up to 50% of TBI cases result from motor vehicle accidents, with males twice as likely to be affected as females.

TBI is clinically rated as mild, moderate or severe based on conventional diagnostic indicators that include duration of loss of consciousness, a Glasgow Coma Scale score (Teasdale & Jennett, 1976), and post-traumatic amnesia (Roebuck-Spencer & Sherer, 2008). It is well documented that TBI can result in a wide range of short- and long-term impairments to the physical, cognitive, behavioural, emotional and social domains depending on the extent, severity and location of the injury (Crowe, 2008). Among these manifold impairments, deficits in psychosocial functioning have been frequently reported as among the most detrimental consequences of TBI (Levin, Grafman, & Eisenberg, 1987; Schwab, Grafman, Salazar, & Kraft, 1993).

While the negative long-term effects of TBI on a person's interpersonal and social behaviour have been well documented, the precise mechanisms underlying these remain unclear. A better understanding of the social impairments resulting from brain injury is therefore needed, along with ways to achieve more effective treatment.

How does TBI Influence Psychosocial Functioning?

Many short- and long-term outcome studies in TBI suggest a less than favourable outlook for many sufferers (Colantonio et al., 2004; Hoofien, Gilboa, Vakil, & Donovick, 2001; Huebner, Johnson, Bennett, & Schneck, 2003; Kersel, Marsh, Havills, & Sleigh, 2001; Sloan, Winkler, & Anson, 2007; Stålnacke, 2007; R. L. Wood, 2008). It has been shown that those who suffer from especially severe TBI have little social contact (Jumisko, Lexell, & Soderberg, 2005; Kersel et al., 2001) and few employment opportunities (McCrimmon & Oddy, 2006; Tsaousides, Ashman, & Seter, 2008). They also display poor social integration skills.

There is evidence to suggest that these social difficulties may be long-lasting. Hoofien et al. (2001), for example, found that in a sample of 60 patients with moderate to severe TBI ten years to twenty years post-injury, approximately 30% had few friends and took little part in social activities. This is corroborated by studies that show a reduced capacity in maintaining relationships and friendships among persons following a severe TBI (Sander & Struchen, 2011). Consequently, people with TBI often feel isolated, lonely and depressed, and this further diminishes their self-esteem and hampers their quality of life (Lefebvre, Cloutier, & Levert, 2008). It is highly probable that a TBI patient's discomfort in social settings dissuades him or her from developing social contacts and partaking in leisure activities, and that this in turn compounds a feeling of isolation and depression.

Other outcome studies indicate that family functioning may also be undermined when a member suffers from TBI (J. M. Douglas & Spellacy, 1996; Ponsford, Olver, Ponsford, & Nelms, 2003; Testa, Malec, Moessner, & Brown, 2006). In a two- to five-year follow-up study, Ponsford and Schönberger (2010) indicate that more than a third of the families surveyed were functioning at an "unhealthy level" two years, on average, after

TBI. Increased family hardship (taking the form of greater emotional distress, disrupted family relationships and a diminished social network) are commonly described by the families of those who have sustained TBI; marital or partnership relationships are also affected (Arango-Lasprilla et al., 2008; R. L. Wood, Liossi, & Wood, 2005). Several researchers further suggest that these antagonistic changes in emotional behaviour and social participation provide more stress to the families of people with TBI than does the concomitant cognitive impairment or physical disability (Marsh, Kersel, Havill, & Sleigh, 2002; Watanabe, Shiel, Asami, Taki, & Tabuchi, 2000).

In short, it appears that TBI can persistently impact on individuals in a range of social contexts such as participation in social activities and engagement in quality relationships. Understanding and uncovering the mechanisms that contribute to these deficits in social function may be important in restoring a satisfactory quality of life to the injured person and his/her family.

Why Focus on Facial Affect Recognition Skills in TBI?

In recent years, research has sought to identify likely contributory factors in the poor social functioning of patients with TBI. A reduced capacity to recognize facial affect after TBI has been found to be one such factor: several studies, indeed, have demonstrated that there is a relationship between facial affect recognition deficits and social dysfunctions in people so afflicted (Knox & Douglas, 2009; Milders, Fuchs, & Crawford, 2003; Pettersen, 1991; Watts & Douglas, 2006). Knox and Douglas (2009), for instance, found that adults with TBI who performed poorly at interpreting expressions demonstrated impaired social participation even after controlling for cognitive factors.

A more recent qualitative case study examining the experience of two adults affected by TBI focused upon the role of communication changes in social relationships (Shorland & Douglas, 2010). Difficulty reading non-verbal emotional cues including facial emotional expressions was cited as one of the key impediments to effective communication, resulting in a lack of peer contact and loss of friendships (Shorland & Douglas, 2010). Pettersen (1991) found that similar to adults with TBI, children and adolescents who had problems reading facial expressions were considered by their parents to be displaying less socially appropriate behaviour.

In keeping with these findings in TBI, evidence from studies of people with autism and people with schizophrenia demonstrated that facial affect recognition is a significant predictor of various aspects of social functioning (Addington, Saeedi, & Addington, 2006; Boraston, Blakemore, Chilvers, & Skuse, 2007; Garcia-Villamisar, Rojahn, Zaja, & Jodra, 2010; Izard et al., 2001; Kee, Gree, Mintz, & Brekke, 2003). The inability to decipher or pick up emotional cues from the faces of others might well prevent an individual with TBI from responding appropriately, which could in turn lead to social rejection. In essence, these findings underscore the important role of facial affect recognition in modulating interpersonal behaviours and social functioning.

It is clear then from the studies reviewed that deficits in social functioning are prevalent after TBI, and that these deficits can be debilitating, causing a deleterious impact on areas such as work, family and interpersonal relationships. Although the underlying reasons for impaired social functioning in TBI are not yet fully understood, emerging evidence discussed above suggests that deficits in recognising facial affect may play a role (Driscoll et al., 2011; Knox & Douglas, 2009). It is not surprising, therefore, that research into the mechanisms underpinning facial affect recognition, and the ability of people with TBI to recognise emotions as conveyed in faces, has gained increasing attention among scientists.

Chapter 2: Facial Affect Recognition

Why is every critical moment in the face of the adult or child so clearly coloured by emotions?

Lev Vygotsky (1987, p. 335)

What is Facial Affect Recognition?

Facial affect recognition is defined as an ability to identify, interpret, and respond accurately to facial affective cues (Suchy, Rau, Whittaker, Eastvold, & Strassberg, 2009). According to Matsumoto et al. (2008), this ability may serve important social functions. Understanding how others are feeling is essential in establishing relationships and developing emotional reciprocity. Accurate recognition and interpretation of facial expressions also helps individuals to make socially acceptable statements and guides them during interpersonal interactions. Thus, difficulties or failures in correctly interpreting facial expressions could negatively affect social interactions and relationships (West et al., 2012). Because of its association with social functioning, the importance of facial affect recognition is reflected in an increased research interest (Wilson, 2010).

Many researchers agree that recognising facial affect is normally intuitive and automatic, and that children develop this skill by the age of 10 (Durand, Gallay, Seigneuric, Robichon, & Baudouin, 2007). A review of literature relating to facial expressions suggests that six basic emotions—happiness, sadness, fear, surprise, anger, disgust—are recognized across different cultures (Ekman, 2004; Matsumoto et al., 2008), although there is no consensus as to which of these is the most readily identified. In some studies, however, happiness has been reported as the easiest, and fear and anger the most difficult (Montagne, Kessels, De Haan, & Perret, 2007).

A variety of factors may influence facial affect recognition abilities. Many studies have demonstrated that factors such as demographic characteristics (e.g. age and gender), environmental influences (e.g., early learning experiences, cultural expectation), mood states, emotional stimulus (e.g., static and dynamic facial features), task demands and social context can influence facial affect recognition abilities (Ambadar, Schooler, & Cohn, 2005; Barrett, Mesquita, & Gendron, 2011; Biele & Grabowska, 2006; Chepenik, Cornew, & Farah, 2007; Clark, Neargarder, & Cronin-Golomb, 2008; Issacowitz et al., 2007; Schmid & Mast, 2010; see review by Sheaffer, Golden, & Averett, 2009). For instance, Schmid and Mast (2010) found that a sad mood had a negative effect on emotion recognition accuracy. Thayer and Johnson (2000), on the other hand, suggested that women were more adept than men at facial affect recognition, although subsequent studies failed to replicate their findings (Grimshaw, Bulman-Fleming, & Ngo, 2004). A recent meta-analytic review concluded that older adults are generally poorer than younger counterparts at correctly recognising negative facial expressions but better at accurately identifying positive expressions (Murphy, Nimmo-Smith, & Lawrence, 2003; Ruffman, Henry, Livingstone, & Phillips, 2008).

Given the complexity of what facial affect recognition encompasses, different tasks have been developed to assess facial affect capacities (see Hall, Bernieri, & Carney, 2005, for a summary). Most of these typically involve the identification, discrimination or matching of basic facial emotional expressions. Identification tasks require participants to choose the appropriate emotional labels for a given expression, while discrimination tasks require participants to ascertain if two stimuli elicit identical or different emotions. The matching tasks require participants to pair a given facial expression with one of several alternatives. The emotional stimuli are generally presented in different formats: static (e.g. photographs) or dynamic (e.g. video, films, animations); black-and-white or colour; subtle or obvious emotional intensity.

Neuroanatomical Substrates Underlying Processing of Facial Cues

Advancements in imaging techniques have allowed considerable progress to be made in understanding the neural mechanisms underlying the processing of facial affect information. As illustrated in Figure 1, converging evidence from functional imaging, event-related potential (ERP) and lesion studies suggest that facial affect recognition relies on a network of neural subtracts (Adolphs, 2002; Fusar-Poli et al., 2009; Heberlein, Padon, Gillihan, Farah, & Fellows, 2008). This network includes the amygdala, insula, basal ganglia, fusiform gyrus, somatosensory regions, superior temporal sulcus and various sectors of the prefrontal cortex, particularly the orbitofrontal cortex and ventral prefrontal cortex. See Herberlein and Atkinson (2009) for a detailed review of neural structures involved in emotion processing.

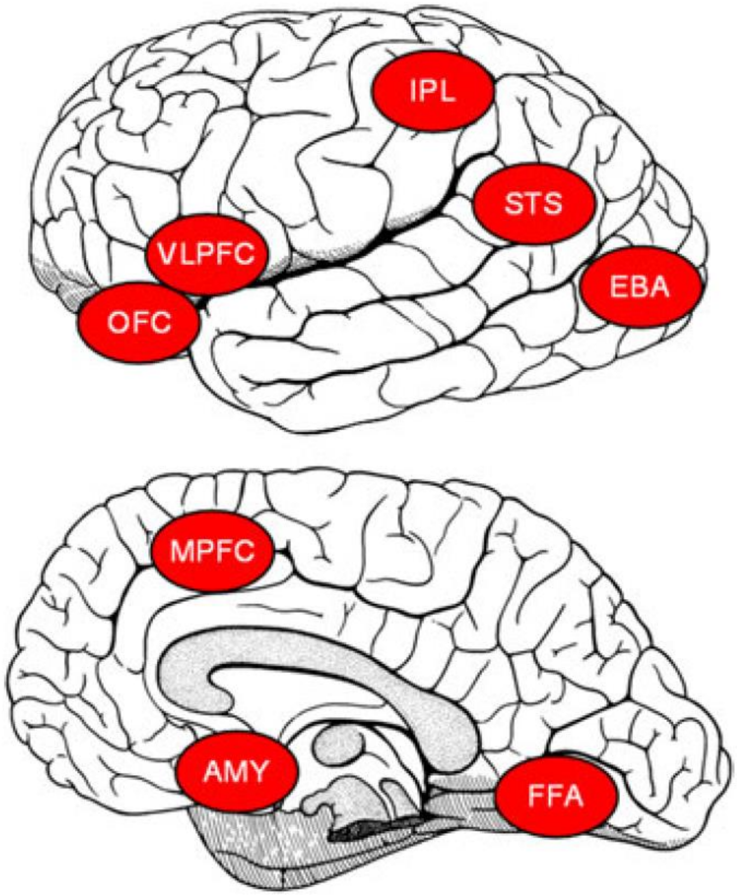


Figure 1. Neural correlates of processing facial cues of emotions and other aspects of social cognitive processing. VLPFC = ventral lateral prefrontal cortex; IPL = inferior parietal lobule; STS = superior temporal sulcus; OFC = orbital frontal cortex; MPFC = medial prefrontal cortex; AMY = amygdala; FFA = fusiform face area. Reprinted with permission from Pelphrey and Carter (2008).

Several studies have suggested that the prefrontal cortex is responsible for processing facial affect cues. Herberlein, Padon, Gillihan, Farah and Fellows (2008), for example, found that individuals with damage to the ventromedial prefrontal lobe had significant difficulty in accurately recognizing facial expressions and reduced capacity in experiencing emotions. A recent meta-analysis of fMRI studies indicates that other areas within the prefrontal regions, such as the ventrolateral and dorsomedial areas, are also involved in facial affect recognition (Fusar-Poli et al., 2009).

Engell and Haxby (2007) demonstrated that the superior temporal gyrus plays an important role in the recognition of facial expressions. In their study carried out with healthy adults, the authors found that the superior temporal gyrus registered a stronger response to emotional expressions than to neutral. In line with this, Adolphs, Damasio, Tranel, Cooper and Damasio (2000) showed that patients with lesions in this region were impaired in identifying facial emotion.

The amygdala has been documented as the region of the brain most pertinently associated with facial emotional processing (Said, Dotsch, & Todorov, 2010). The difficulty in facial affect recognition resulting from damage to this region is said to be due to a tendency to ignore the eyes when analysing emotion in the face (Adolphs et al., 2005). Adolphs et al. (2005) presented participants with isolated features of faces and instructed them to identify the emotion being conveyed. Only participants with amygdala damage experienced difficulty identifying emotions from eyes seen in isolation. This finding has been further supported by a recent study that employed both fMRI and an eye movement paradigm (Gamer & Büchel, 2009).

There is some consensus that the neural substrates subserving specific emotions are at least partially distinct. Using imaging techniques, several studies have demonstrated that sad or fearful faces are linked with the amygdala (Adolphs, 2002; Adolphs & Tranel, 2004; Sato, Kochiyama, Yoshikawa, Naito, & Matsumura, 2004), angry faces with the orbital frontal regions (L. M. Williams et al., 2005), and happy faces with the cingulate sulcus and the fusiform gyrus (Murphy et al., 2003). It appears that damage to a specific substrate may thwart the accurate identification of specific emotions.

Neuropsychological and behavioural studies have contributed to our knowledge of facial affect recognition. These studies have shown that the structures in the right hemisphere are more adept at emotion recognition than those in the left (i.e., greater impariments after right hemisphere damage; Adolphs, 2002; Bourne, 2008; Karow, Marquardt, & Marshall, 2001). Several lesion studies have reported that negative facial affect is processed primarily by the right hemisphere, and positive facial affect by the two hemispheres equally (Mandal, Tandon, & Asthana, 1991). In contrast, a recent study by Nijboer and Jellema (2012) highlighted the involvement of the right hemisphere alone in processing of positive and negative expressions.

Taken altogether, these studies point to an extensive neural network dedicated to facial affect recognition. This network includes cortical and subcortical areas that may process different emotions. Although current evidence is tenuous as to the roles of specific brain regions in facial affect processing, it appears that damage to any of these areas may impair facial affect recognition.

Theories of Facial Affect Recognition

There are several theoretical frameworks that explain the mechanisms behind facial affect recognition, all of which are being debated. The predominant theories with respect to this phenomenon have two primary components: (1) accurate recognition of relevant facial features and (2) accurate interpretations of one's own emotional state. The accurate recognition of facial features requires that these be cohesively processed (Haxby, Hoffman, & Gobbini, 2000). In this regard, several perceptual and behavioural experiments have proposed that information drawn from a whole face (integrating all facial features) and information extracted from individual facial features are both critical to facial affect recognition, although evidence as to their specific roles is somewhat mixed (Calder & Young, 2005; Eisenbarth & Alpers, 2011; Schwaninger, Wallraven, Cunningham, & Chiller-Glaus, 2006; Sullivan, Ruffman, & Hutton, 2007). Parallel to this, there are neuroimaging studies that suggest some brain areas are important for processing features of facial affect holistically while others process them feature by feature (Adolphs et al., 2005). Once the relevant facial features are processed, an emotion can be inferred.

The accurate interpretation of emotional states may partly require the use of one's own internal experiences of emotion to help in identifying others' feelings (Adolphs et al., 2000; Halberstadt, Dennis, & Hess, 2011; Hornak et al., 2003). This is supported by the simulation theory which suggests that ascertaining others' feelings from processing facial features involves the evocation of emotional states in oneself (Goldman & Sripada, 2005; Keysers & Gazzola, 2009). Several imaging studies have found evidence for somatosensory cortex, anterior and posterior cingulate, insula and ventromedial prefrontal cortex involvement in recognizing our own emotions (Barrett & Wager, 2006; Critchley et al., 2000; Heberlein et al., 2008; Pitcher, Garrido, Walsh, & Duchaine, 2008). Individuals with TBI who have difficulty with self-emotion processing have also been shown to have problems identifying the facial expressions of others (Hornak et al., 2003; Hornak, Rolls, & Wade, 1996; McDonald et al., 2011). These individuals typically have damage to the somatosensory cortex or the ventromedial prefrontal cortex.

Emotions can also be inferred through social contexts (McDonald, Flanagan, Rollins, & Kinch, 2003). This is particularly important because the literal meaning of a transmitted message might not be representing its intended meaning. Recognition of the context in which a message was transmitted, especially when facial cues are lacking or absent, can help a recipient to interpret messages and infer emotions accurately. Gibbs (2002) stated that drawing inferences based on social context occurs instantaneously with comprehension of the message, and is referred to as the “direct access view” (p. 460) of understanding inferences. Listeners do not need to initially process the literal meaning of the message. The inference drawn, therefore, depends greatly on the social context in which a message was delivered.

Social context, beyond facial expressions, includes information about social situations, personal desires and social behaviours. Certain events tend to elicit particular emotions and behaviours; if a person’s desires, wants and beliefs are understood, one can posit that this event will determine the likely positive or negative emotional consequences of a particular event. Weiner, Stern and Lawson (1982) proposed an attribution-emotion model that asserts two forms of emotional inferences. In the attribution independent model, one person draws inferences about another’s emotions through his or her own experiences of having succeeded or failed when in that same situation. The attribution dependent model differs from this in that the underlying cause of success or failure is considered. Nevertheless, both types of emotion inference consider the positive and negative aspects of the situation. For example, a teenage boy asks a girl to the school dance and meets with a refusal. If the inferred emotion is attribution independent and the girl’s reason for refusing is not considered, one can assume that the boy will feel sad. If, however, we know that the girl led the boy to believe she would accept his invitation and then did not do so, an attribution dependent inference is drawn and one can suppose that the boy will feel angry (Thompson, 1987; Weiner et al., 1982).

In short, accurate perception of emotional cues requires the ability to pay attention to important facial features and to understand one’s own emotional experiences. Understanding other people’s emotions can also be achieved by relying on social contextual cues. Several brain regions have been implicated in facial affect recognition difficulties. The specific role for each of these regions needs further definition, however. Altogether, the studies reviewed suggest that facial affect recognition is complex and multidimensional and may serve important interpersonal and social functions. Figure 2 presents one visual depiction of a possible pathway by which these components interact.

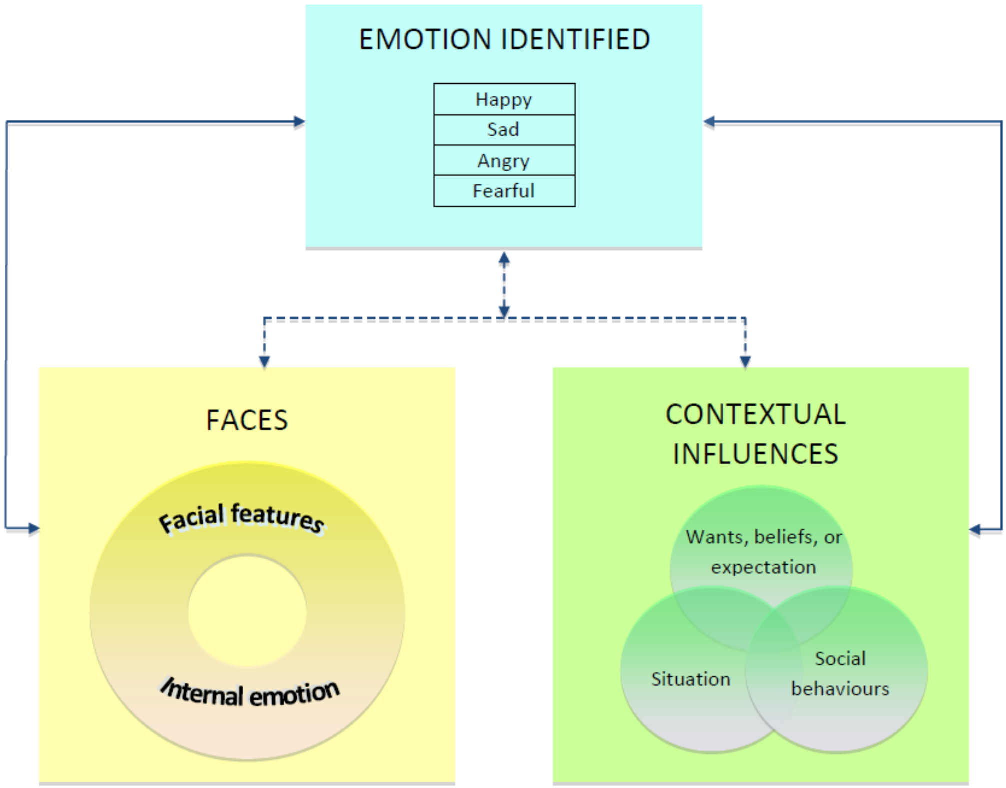


Figure 2. Visual depiction of possible pathways of interaction between components of facial affect recognition.

Chapter 3: Facial Affect Recognition in People with TBI

How does TBI Influence Facial Affect Recognition?

A recent meta-analysis has shown that up to 39% of people with moderate to severe TBI display significant deficits in facial affect recognition (D R Babbage et al., 2011). This is not entirely surprising, as it has been established that the areas of the brain involved in affect processing are commonly injured as a result of TBI (Radice-Neumann, Zupan, Babbage, & Willer, 2007). Three recent reviews concluded that individuals with TBI who are unable to recognize emotions from nonverbal cues, especially facial expressions, may also be impaired in identifying emotions from social contexts (Bornhofen & McDonald, 2008a; McDonald, 2013; Radice-Neumann et al., 2007). Such difficulties appear to be associated with poor social outcomes (Knox & Douglas, 2009; Watts & Douglas, 2006). Although much is known about how TBI impacts on facial affect recognition, studies evaluating targeted methods for improving facial affect recognition skills in this clinical group are lacking.

Early studies suggested that adults with TBI are impaired in facial affect recognition tasks (Braun, Baribeau, Ethier, Daigneault, & Proulx, 1989). Prigatano and Pribram (1982), for example, were the first to underscore a deficit in facial affect recognition in their study of people with TBI. They reported that these individuals performed less successfully than individuals with other types of brain injury (i.e., stroke and brain tumour) in tasks requiring participants to perceive and recall facial affect. Similarly, Jackson and Moffat (1987) and Braun et al. (1989) confirmed that people with severe TBI had difficulty processing facial expressions.

Subsequent studies have reached similar conclusions (Croker & McDonald, 2005; Green, Turner, & Thompson, 2004; Martins et al., 2012; C. Williams & Wood, 2010). Spell and Frank (2000) examined recognition of facial emotion and vocal prosody in participants with TBI (n=24) and healthy matched controls (n=24). Participants were given the Receptive Facial Expression (Faces) Subtest—derived from the Diagnostic Assessment of Nonverbal Affect-2—for four different emotions (happy, sad, angry, and fearful). The study found that participants with TBI performed worse than controls in the facial emotion perception tasks.

In a study controlling for time post-injury, Green, Turner and Thompson (2004) administered facial emotion discrimination and labelling tasks to individuals with recent TBI (on average 2.6 months post-injury) and to matched controls. Results demonstrated that in both facial expression tasks, TBI participants performed less accurately than the controls. Another study of TBI individuals conducted within 60 days of their injury replicated these findings (Borgaro, Prigatano, Kwasnica, Alcott, & Cutter, 2004). Further support for deficits in emotional perception in TBI comes from neuroimaging studies. Using a number of imaging techniques, various studies have demonstrated that several brain areas facilitating emotion perception are commonly damaged in TBI (Radice-Neumann et al., 2007). In summary, accumulating evidence has demonstrated that adults with TBI are impaired in facial affect recognition (D R Babbage et al., 2011; Knox & Douglas, 2009; Milders et al., 2003; C. Williams & Wood, 2010).

In terms of hemispheric difference, evidence drawn from studies of individuals with unilateral brain damage suggests that the right cerebral hemisphere is dominant over the left in facial affect recognition (Kucharska-Pietura, Phillips, Gernand, & David, 2003). Kucharska-Pietura and colleagues (2003) found that adults with damaged right cerebral hemispheres fared worse in emotion perception tasks (face and prosody) than healthy individuals and those with damaged left cerebral hemispheres. Allerdings and Alfano (2006), however, argued that deficits in emotion recognition cannot necessarily be traced to the right hemisphere exclusively—the left cerebral hemisphere may play an unidentified role.

Other studies indicate that deficits in facial affect recognition are pervasively manifest in people with TBI. The inability of people with TBI to recognize facial affect has been documented with a variety of facial emotion perception tasks: recognition, matching, labelling, and discrimination between facial expressions (Milders et al., 2003; Watts & Douglas, 2006). Correspondingly, these people show impairment on a wide range of facial affect measures such as the Diagnostic Assessment of Nonverbal Affect-2 (Nowicki, 2010), the Florida Affect Battery (Bowers, Blonder, & Heilman, 1991), and the Awareness of Social Inference Test (McDonald et al., 2003). A similar pattern was observed when static stimuli (e.g. photographs) or dynamic stimuli (e.g. video clips) were employed. Knox and Douglas (2009) used both static and dynamic displays to examine perception of facial emotion. Overall, in comparison to the controls, individuals with TBI were impaired in interpreting facial expression. The TBI group was less accurate in identifying emotions through dynamic facial expression than through static facial expression. It appears that the neural pathways for processing facial affect may be distinct, although the difference may be a result of task difficulty.

This phenomenon seems not to be limited to patients with severe head injuries, but can also be found in those with mild and moderate head injury (Kubu, 1999). Additionally, reduced facial emotion perception ability is evident in individuals both acutely following brain injury as well as many years after injury, with impairment in this area seeming to remain stable over time (Borgaro et al., 2004; Spell & Frank, 2000). Ietswaart, Milders, Crawford, Currie and Scott (2008) longitudinally examined the changes in emotion recognition deficits in patients suffering from TBI. The TBI group performance in recognition of facial affect was significantly below the level of the control group, even at one year follow-up. The authors suggest that facial affect recognition deficit results directly from damage to the brain and does not improve with time.

People with TBI have atypical processing of emotional facial expressions. Several researchers have shown that people with TBI are significantly worse at recognizing negative emotions such as anger, disgust, sadness and fear than they are at recognizing positive facial emotions such as happiness, joy and surprise (Croker & McDonald, 2005; Green et al., 2004; Hopkins, Dywan, & Segalowitz, 2002; H. F. Jackson & Moffat, 1987; Kucharska-Pietura et al., 2003). Using an electrodermal activity paradigm, Hopkins et al. (2002) instructed 15 adults with TBI to look at a series of pictures showing varied facial expressions. These adults registered lower electrodermal responses when viewing negative facial expressions (particularly fear) than when viewing positive expressions. Similarly, Kucharska-Pietura et al. (2003) found that individuals with TBI were more accurate in recognizing happy faces. It appears that some types of facial affect are easier to recognize than others.

In line with the aforementioned, preliminary evidence suggests that TBI-affected individuals may employ different strategies when processing facial emotional information. Vassallo, Douglas and White (2011), for example, reported that in comparison with healthy individuals, patients suffering from severe TBI did not demonstrate any preference for specific facial areas when evaluating facial pictures. The authors suggest that this may explain the apparent difficulties that TBI-affected individuals face in recognizing emotions. Collectively, these findings indicate that deficits in facial affect recognition are a real problem for many people with TBI. These deficits are unlikely to be uniform, however, in part because of the heterogeneity of the brain lesions. The mechanisms underlying facial affect recognition impairments after brain injury therefore warrant further investigation.

How does TBI Influence Other Forms of Emotion Recognition?

In addition to impaired facial affect recognition, people with TBI have difficulties in recognising emotions from vocal prosodies, physical gestures, body postures and contextual parameters (H. F. Jackson & Moffat, 1987; see review by McDonald, 2013; McDonald et al., 2003; Spell & Frank, 2000; C. Williams & Wood, 2010; Zupan, Neumann, Babbage, & Willer, 2009). For the purpose of this research, only contextual parameters will be discussed. The extent to which a given social situation interacts with one's own beliefs and assumptions is another means of inferring a person's emotional state (e.g. taking it for granted that a family is happy because they have won the lottery and they needed money). This ability, also known as "theory of mind", is especially useful in contexts where facial expressions are unavailable.

There is evidence suggesting that people with TBI have marked deficits in theory of mind (McDonald, 2013). Bibby and McDonald (2005) reported that TBI participants performed poorly in false belief tasks that measured the ability of participants to understand that another person can hold a mistaken belief. Channon, Pellijeff and Rule (2005) found that participants with TBI had more difficulty interpreting sarcastic comments than was the case with control participants. A more recent study by Muller and colleagues (2010) has further extended research in this area by demonstrating that people with severe TBI perform significantly worse than control groups on both verbal and nonverbal theory of mind tasks. All these findings were further strengthened by a meta-analytic study of 26 empirical studies, which concluded that theory of mind ability is compromised following TBI (Martin-Rodriguez & León-Carrión, 2010). Given the susceptibility of the area within the prefrontal cortex during a TBI (an area which underpins determining theory of mind capacity), one would expect that individuals with

TBI will have significant difficulty inferring emotions based on contextual cues. This has indeed been found to be the case (e.g., Byom & Turkstra, 2012; Henry, Phillips, Crawford, Ietswaart, & Summers, 2006; McDonald, 2013).

Deficits in theory of mind may also be related to impaired facial affect recognition. Henry, Phillips, Crawford, Ietswaart and Summers (2006), for example, demonstrated a correlation in adults with TBI between performance in emotion recognition tasks and theory of mind abilities. Such associations were replicated in people with autism. More recently still, a study by Mier and colleagues (2010) has presented fMRI evidence showing overlapping brain activity in response to two conditions: one requiring decoding of facial expressions, the other decoding of intention.

The results from these studies are in line with a model proposed by Tager-Flusberg and Sullivan (2000). According to Tager-Flusberg and Sullivan, theory of mind involves two distinct components—social perceptual and social cognitive—the former referring to the immediate online judgment of a person’s mental and emotional state based on perceptual features (e.g. facial cues), with the latter involving more complex cognitive inference relating to the nature of another’s mental state. Given the impaired recognition of facial emotional expressions and the misinterpretation of mental states observed in people with TBI, it is likely that both social perceptual and social cognitive aspects of theory of mind are impaired in these individuals.

Corroborating findings of difficulty experienced in emotion recognition is the observation that these people appear to have compromised empathy capacity (de Sousa et al., 2010; R. L. Wood & Williams, 2008). Empathy is strongly correlated with relationship satisfaction and therefore important to consider when discussing impaired emotion recognition. Baron-Cohen and Wheelwright (2004) define empathy as the ability to attribute mental states to others, and to respond appropriately to another person’s mental state. Decety (2011) suggests that empathy requires a person to experience emotions within themselves and be able to infer what others are thinking and feeling (i.e., theory of mind). Several studies found that patients with damage to the ventromedial prefrontal area had impairment in emotion recognition, empathy and theory of mind (Mah, Arnold, & Grafman, 2005; Shamay-Tsoory, Tomer, & Aharon-Peretz, 2005; Xi et al., 2011). Wood and Williams (2008) demonstrated that their participants with brain injury had impaired empathy and low scores on a test of emotion recognition. This is not surprising, given that both are associated with brain structures susceptible to TBI, such as the prefrontal cortex (Nummenmaa, Hirvonen, Parkkola, & Hietanen, 2008; Shamay-Tsoory, Aharon-Peretz, & Perry, 2008).

Taken together, these findings suggest that many people with TBI exhibit a significant deficit in affect recognition, particularly in recognizing facial affect. Such difficulties may partly underlie whatever social dysfunction they experience. The extent, however, to which facial affect recognition deficits contribute to social problems in TBI warrants further investigation. Given the magnitude of facial recognition difficulties in people with TBI, the development of treatments to address the problem is essential.

Is There a Link Between Facial Affect Recognition Impairment and Cognitive Dysfunction?

It is well-documented that people may suffer from a range of impairments in cognitive functioning following TBI (Roebuck-Spencer & Sherer, 2008). These cognitive impairments often relate to attention, working memory, information processing speed, and executive functions (Dikmen et al., 2009). Many of these cognitive deficits have been demonstrated to be stable over time (Draper & Ponsford, 2008; Ruttan et al., 2008) and even found to predict social functioning, employment and self-care (Ponsford, Draper, & Schönberger, 2008). In addition to cognitive impairments, a substantial number of people with TBI have an impaired ability to recognize facial emotions, as described in Chapter 2. The actual reasons underlying the deficits in performance in measures relating to facial affect are, however, still unknown. For the purpose of this dissertation, *cognitive functioning* refers to general cognitive abilities that do not involve any affective component, such as language, attention, memory and executive functioning. It remains unclear whether they indicate a specific difficulty in processing affective information or whether they could be considered simply a part of a person's cognitive impairment.

There is currently a debate in the literature about whether a deficit in facial information processing is specific to facial emotion or reflective of cognitive functioning impairments. Most investigation within this area has been drawn from schizophrenia, and findings are inconclusive (Addington, Girard, Christensen, & Addington, 2010; Bryson, Bell, & Lysaker, 1997; Pinkham, Penn, Perkins, & Lieberman, 2003; Sachs, Steger-Wuchse, Kryspin-Exner, Gur, & Katschnig, 2004). The argument that supports a specific impaired facial affect recognition mechanism comes from two primary findings. Firstly, accumulated evidence from neuroimaging and lesion studies has indicated that certain areas of the brain are necessary for facial affect recognition (see review by Adolphs, 2002). Secondly, correlational studies of patients with schizophrenia reported weak or non-existent associations between facial emotion recognition impairments and cognitive variables (Pinkham et al., 2003; Shamay-Tsoory et al., 2007). In addition, dissociation between different aspects of social cognition (including affect recognition and theory of mind) and general cognitive abilities is evident in other clinical populations; individuals with autism, for example (Adams, 2011).

However, some studies provide counter-evidence. Sachs et al. (2004), for example, used a neuropsychological test battery that assessed a wide range of cognitive domains (abstraction-flexibility, attention-vigilance, verbal memory, nonverbal memory and language processing) in 40 patients with schizophrenia. They reported that a measure for recognition of emotions was correlated with verbal memory, abstraction-flexibility and language processing. Consistent with this, Henry, Bailey, von Hippel, Rendell and Lane (2010) found that alexithymia in people with schizophrenia was related to poorer cognitive functioning. Other researchers have shown that deficits in executive functioning and working memory may account for the poor performance in emotion recognition tasks of individuals with multiple sclerosis (Henry et al., 2009b). All these findings indicate that cognitive functioning may underpin the ability to accurately recognize facial affect in other people. It is conceivable that if an individual is unable to strategically scan and collect visual information or hold affective information online, his or her capacity to gather emotions from facial expressions will be diminished.

Only three published studies (Allerdings & Alfano, 2006; Spikman et al., 2012; Tonks et al., 2008) have directly investigated the relationship among TBI patients between deficits in facial affect recognition and cognitive impairment. Similar to the findings for schizophrenia, these three studies have yielded mixed results. The controversial findings in this literature regarding the emotion recognition–cognition link may be attributed in part to limited tests for assessing cognitive domains and also to the use of pencil-and-paper-based neuropsychological batteries. It has been suggested that the pencil-and-paper neuropsychological tests may be insufficiently sensitive in detecting cognitive impairments, thus potentially invalidating the test data: such a phenomenon has been demonstrated in a sample of concussed adult athletes (Makdissi et al., 2001). More comprehensive and sensitive neuropsychological measures are therefore needed to directly test the role of cognitive factors in emotion recognition.

Overall, current evidence as to whether facial affect recognition and cognitive functioning are related remains tenuous. Given that people with TBI present clear deficits in the domains of emotion perception and cognitive functions, more research is warranted directly examining the nature of the relationship between the two domains. As interventions are developed aimed at improving emotion recognition skills, studies determining whether the extent of improved recognition is related to the level of cognitive functioning could shed further light on this area. Investigation which may uncover the precise mechanisms differentiating facial affect recognition from cognitive functioning could have important implications both theoretically and in terms of rehabilitation.

Chapter 4: Facial Affect Recognition Training

Can Facial Affect Recognition Skills in TBI be Restored?

Cognitive rehabilitation has been shown to be effective in improving cognitive functioning for patients with TBI (Cicerone et al., 2005; Cicerone et al., 2011). Two systematic meta-analytic studies provide compelling evidence supporting the use of cognitive remediation strategies to overcome a host of cognitive deficits after TBI (Cicerone et al., 2011; Rohling, Faust, Beverly, & Demakis, 2009). Techniques such as vanishing cues, feedback, and use of specific computer-based programmes have been listed as some of the effective cognitive remediation strategies used in the field of brain injury rehabilitation. Despite this, research is only now beginning to explore the remediation of facial affect recognition deficits in the TBI population. Given that people with TBI can benefit from cognitive rehabilitation interventions, they may also be helped by the proposed affect recognition training.

Research investigating the trainability of facial affect recognition has been carried out essentially on people with autism. As with people with TBI, these people have impoverished emotion recognition skills including deficiencies in identifying facial affect and inferring emotion in social contexts (see review by Harms, Martin, & Wallace, 2010). A growing number of successful training programmes have been developed to enhance facial affect recognition in adults and children with autism (Baron-Cohen, Golan, & Ashwin, 2009; Bölte et al., 2006; Lacava, Golan, Baron-Cohen, & Myles, 2007; Ryan & Charragáin, 2010; Silver & Oakes, 2001). Hadwin, Baron-Cohen, Howlin and Hill (1996), for instance, taught 10 children with autism to recognize the photographed facial expressions of happiness, sadness, anger and fear using a question–answer format with corrective feedback. These children were also taught about different situations, desires and beliefs that could cause different emotions. The accuracy of the children’s facial affect recognition improved significantly after eight days of training.

Golan and Baron-Cohen (2006) also included a task of facial affect recognition in their computerized multi-programmes geared to teach emotions and mental states to adults with Asperger’s disorder. The facial affect was presented in video clips along with definitions of each emotional expression. Participants were asked to associate the video clips of facial expressions with affective words. After 10-15 weeks (with about two hours weekly) of computer intervention, participants improved significantly in their ability to associate specific facial affects with appropriate affective words.

A more recent study by Ryan and Charrágain (2010) investigated the effectiveness of four one-hour sessions of emotion recognition training, with a waiting list control group, in 33 children with autism (30 boys, 3 girls). These children were required to learn the constitutive parts of specific facial expressions (instead of the whole face). Results indicated that those who received the emotion recognition training showed significant gains in the emotion recognition task even at a follow-up session three months later.

Facial affect recognition impairments in other clinical populations have also been shown to respond to targeted emotion recognition training. The patients have included individuals with schizophrenia (see review by Horan, Kern, Penn, Green, & Penn, 2008), learning disabilities (P. M. Wood & Kroese, 2007) and eating disorders (Money, Davies, & Tchanturia, 2011). In the schizophrenia context, for example, Mazza, Lucci and Pacitti (2010) developed a group treatment that required participants to observe photos, paintings, figures, strips and imitations of facial emotional expressions. Sixteen patients with schizophrenia who received this training improved significantly on measures of emotion recognition, social functioning and theory of mind, compared to a control group that received problem solving training. In short, the success these studies have enjoyed suggests that facial affect recognition is an impairment that can be rehabilitated.

Despite this, only five studies have investigated methods for training facial affect recognition in persons with TBI. In the first, Guercio and colleagues (2004) found that deficits in facial affect recognition in three adults who had suffered brain injury could be reduced by stimulus equivalence techniques—directly training a person through reinforcement to associate pictures of facial affect with their corresponding verbal or written descriptors. Similar positive effects were reported by two subsequent randomized controlled studies using other cognitive remediation strategies such as errorless learning, reinforcement and self-monitoring (Bornhofen & McDonald, 2008b, 2008c). Bornhofen et al. (2008c), for example, compared two training approaches (errorless learning and self-instruction training) for treating emotion perception deficits in 18 individuals with TBI (17 male, 1 female). The training was administered in 10 2.5-hour sessions over 10 weeks. Participants exhibited improved ability to recognize emotion from static using either strategy, while social inferences were improved only through self-instruction training.

A US pilot study by Radice-Neumann, Zupan, Tomita and Willer (2009) investigated the efficacy of two computer-based training programmes for two aspects of emotion recognition processing in adults with TBI. One programme focused on retraining people to identify emotions in others through analysis of facial expressions (*Faces*), the other on retraining identification of emotions through social context (*Stories*). Nineteen adults with moderate to severe TBI were randomly assigned to either *Faces* or *Stories* training. Both types of training consisted of six to nine sessions over a two-week period, with each session lasting one hour. Results showed that the *Faces* group not only improved in emotion recognition from faces but also extended this skill to social contexts and social-emotional behaviours. *Stories* training, on the other hand, led only to improved ability to infer how members of the group would feel in a given context.

In contrast to the experiments outlined above, another intervention study incorporating facial mimicry and focused attention remediation strategies for development of facial affect recognition skills in adults with TBI, proved inconclusive (McDonald et al., 2009b). Significantly, this study provided only a brief intervention—a single session consisting of two different treatments for 20 minutes each. In this case, the lack of success of the two strategies might well have been attributable to the short duration of the training.

While evidence from the aforementioned training studies suggests that people with TBI can at least be taught to accomplish facial emotion recognition tasks successfully, several drawbacks should also be noted. Many had only small sample sizes, some had no control groups, and few measured the durability of the treatment gains. Moreover, in Guercio et al's study (2004), the emotional stimuli used for assessment and treatment were the same. The treatment effects may then have been due to practice rather than to the benefits of the treatment per se. In McDonald et al.'s study (2009b), on the other hand, the training programme was very short-term (the participants were trained on one day and tested the same day). More broadly, although facial affect recognition can be improved by training to a certain degree, the precise extent to which these training-related benefits can be generalized to real life is unclear. Such limitations notwithstanding, the five training studies provide initial support for the hypothesis that people with TBI can be trained to recognize emotions in others.

In essence, these findings underscore the need for development of treatment strategies to enhance facial affect recognition for people with TBI. Better controlled trials with larger TBI samples are required to strengthen the effectiveness of the early interventions and determine whether they are clinically practicable. It would be valuable to address the question of whether improvement in facial affect recognition is durable, and whether it can be generalized to social functioning. It is also important to investigate whether cognitive functioning influences treatment outcomes. An interesting and highly relevant question is whether cognitive abilities need to be remedied before training in facial affect recognition can be effective. All of this increased awareness would perhaps shed light on the nature of the relationship between facial affect recognition and cognition, and assist clinicians in predicting those patients most likely to benefit from interventions.

Summary

The studies reviewed indicate that while difficulties in facial affect recognition pose a challenge to a significant number of people with moderate to severe TBI, little is known about appropriate treatment for this condition. Evidence from facial affect recognition intervention strategies designed for patients with autism has provided impetus for the development and evaluation of intervention strategies for people with TBI. Improving facial affect recognition skills may be a potential rehabilitation tool to improve social functioning for this clinical group and that would be a highly valuable outcome. For enhanced insight into the nature of social cognition, it is essential that there be a sounder understanding of ways in which various cognitive factors may relate to the processing of facial affect recognition. A grasp of the theoretical models underpinning facial affect recognition could result in an important contribution to the development of effective intervention strategies. Ultimately, these might improve the quality of life of people with TBI and their families.

Chapter 5: Rationale and Goals of the Present Research

TBI can have significant adverse consequences, with social difficulties reported to be the most debilitating for patients and their families. Deficits in the ability to recognize the emotions of others are believed to be one key factor contributing to this. The preceding chapters have highlighted that facial affect recognition impairments are prevalent in people with TBI. Although there is now evidence showing the high prevalence of facial affect recognition deficits in people with TBI, few remedial interventions exist for this population. As noted earlier, only five published treatment studies have been identified to date, and while the overall findings of these studies would seem encouraging, the interventions are as yet at a somewhat rudimentary stage. The initial treatment studies were limited by several factors, leaving the efficacy of the interventions open to question. More research is required, therefore, to develop and evaluate the efficacy of interventions for training people with TBI to recognize facial affect in others.

The present research—which formed part of an international multi-centre clinical trial—had as its first goal an evaluation of the effectiveness of two new training programmes designed to improve different aspects of emotion recognition in adults with TBI. A US-based pilot study had indicated merits in these treatment approaches (Radice-Neumann et al., 2009). Based on the initial findings from that study, the efficacy of these two types of treatment—further refined and extended—were examined in a full randomised controlled clinical trial conducted in three separate locations. Our study was based in Wellington/Palmerston North, with parallel sites in Ontario and North Carolina. This three site clinical trial sought to extend previous studies by including: a larger sample size (pooling data across three sites); a randomised control group with a plausible alternative 'sham intervention'; and the use of comprehensive measures and rigorous methods. Additionally, the trial sought to examine the durability of the treatment effect by doing a three- and six-month follow-up, and also attempted to assess the extent to which it could be applied to real world social contexts by obtaining ratings from both participants and their caregivers. These ratings came from self-report measures relating to changes in participants’ social behaviour after training.

While, as mentioned earlier, the original impetus for this wider project was not mine, I was involved in team discussions around implementation of the research design, in the Ethics application to the Central Regional Health Disability, in the recruitment of participants, and in the provision of treatment to the New Zealand sample at the Wellington site (n= 14). In addition, I conducted an independent analysis of the data relating to the effectiveness of the two new interventions from across all three sites, with the research team’s support. The analysis of these outcomes presented in the wider project therefore represents my own work, with only the usual doctoral supervisory input.

The second goal was to clarify the inconsistent findings regarding the relationship between facial affect recognition and cognitive functioning. A better understanding of the relationship between the two domains has theoretical importance, as it would verify whether there is a basic distinction between their underlying neural substrates and mechanisms. This area of research has been identified as a key activity within the emerging field of social cognitive neuroscience. If the factors underlying affect recognition processing can be delineated, effective intervention might be devised to ameliorate these; and this development should of course prove beneficial to individuals with TBI.

A specific responsibility that I had agreed to undertake at the New Zealand site on behalf of all three international sites was to examine the role of cognitive factors in facial affect recognition. Specifically, I examined: (1) the correlations between facial affect recognition impairments and cognitive functioning after TBI; (2) baseline cognitive variables and other demographic characteristics associated with treatment response; (3) whether improvement in emotion recognition skills after training was related to changes in cognitive functioning, and if so, the specific cognitive domains that were involved. All this investigation was entirely my own, my sole responsibility within the trial, and an original contribution to the overall project. Examination of the area may help to ascertain whether the success of treatment outcome depends on the level of cognitive functioning. This study was the first to address this question directly, in the context of TBI, by using a computerised neuropsychological cognitive battery, CogState (CogState Ltd., Melbourne, Australia), for assessment of changes in cognitive functioning. The administration of CogState before and after treatment allowed us to determine whether there were changes in cognitive abilities after emotion recognition skill training.

In sum, the goals of this thesis were threefold:

1. To evaluate the efficacy of two new affect recognition training programmes in comparison with a control group, assessing the maintenance of the treatment effects at a three- and six-month follow-up, and assessing the possible general application of the treatment to real-life social contexts.
2. To examine the relationship between cognitive functioning and facial affect recognition impairments.
3. To explore the baseline variables associated with improved facial affect recognition, and to examine whether any changes in cognitive performance were apparent after treatment, and to explore the baseline variables associated with improved facial affect recognition.

Hypotheses

Based on the initial findings from the pilot study in North America and the current literature, I hypothesized that:

1. Participants in the *Faces* group would significantly improve their ability to recognize emotions from faces in comparison with the Control group.

2. Participants in the *Stories* group would improve in their ability to infer emotions from written contextual information in comparison with the Control group.

3. Participants in the *Face*s and *Stories* groups would show enhanced empathy, reduced irritability, aggression, and depression, and would have less stressful relationships after training, in comparison with the Control group.

4. Improvement in emotion recognition, empathy, and reduced aggression as a result of training would be maintained over time and would be present at three- and six- month post-treatment.

5. Given the contradictory findings regarding the relationship between facial affect recognition and cognitive functioning, no hypotheses were made concerning the link between the two domains and the possibility of changes in cognitive functioning after training.

Chapter 6: Study One Methods

A man when moderately angry, or even when enraged, may command the movements of his body, but… those muscles of the face which are least obedient to the will, will sometimes alone betray a slight and passing emotion.

Darwin (as cited in Ekman, 2003, p. 206)

Design

This study was part of a randomised controlled multicentre trial carried out in Charlotte, North Carolina, USA; St Catharines, Ontario, Canada; and Wellington/Palmerston North, New Zealand. This trial compared the effectiveness of two training programmes designed to improve different aspects of facial affect recognition in people with TBI to an active placebo control. On the basis of data from the previous pilot study, a sample size of 21-22 participants would be needed for each treatment group in order to show an effect size of 0.4 at 80% power for the primary outcome measure—facial affect recognition. To allow for participant attrition, however, it was planned to recruit 30 participants for each treatment group. The total sample size was therefore determined at 90, gathered from the three sites mentioned at the outset. An overview of the study design is presented in Figure 3.

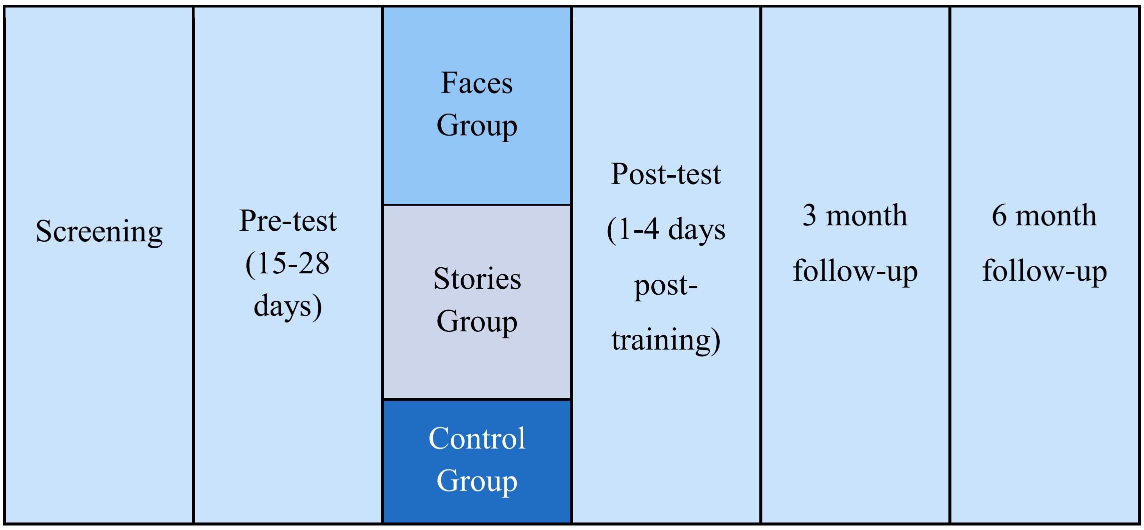


Figure 3. Summary of the study design.

Participants

It was planned to recruit approximately 25% of the participants in New Zealand, 25% in Ontario, and 50% in North Carolina. Participants were eligible for inclusion if they:

a. were aged from 18 to 65 (to control for developmental or age-related confounds);
b. were aged eight years or more at the time of injury;
c. had suffered an open or closed traumatic brain injury;
d. had sustained a moderate to severe injury as determined by a Glasgow Coma Scale score of 12 or less, or post-traumatic amnesia or loss of consciousness of at least 24 hours;
e. demonstrated sustained impairment in facial affect recognition, by performing at least 1.5 standard deviations below the age-group norm on the subtest of the Diagnostic Assessment of Nonverbal Affect-2 Adult Faces at initial screening and maintained a score of at least 1.0 standard deviation below the age-group norms at pre-testing two weeks later;
f. had adequate visual acuity to complete task requirements as determined by the Facial Identity Discrimination sub-test performance from the Florida Affect Battery;
g. registered scores of at least 75% accuracy on the Discourse Comprehension Test, demonstrating adequate reading, hearing and listening skills to undertake task requirements;
h. were able to express a basic understanding of descriptions on the Emotion Context Test (e.g. happy, sad, angry, fearful), thereby showing a capacity to understand treatment tasks; and
i. had access to an informant (e.g. family member or close friend) available to fill out questionnaires about the participant's behaviour and his/her own relationship with the participant.

The exclusion criteria were having:

a. any congenital or developmental impairment, or pre-injury neurological condition, such as anoxia/hypoxia, stroke or tumours;
b. any uncorrected visual acuity impairment;
c. any hearing impairment, aphasia, or severely impaired receptive or expressive language;

d. any presence of visual neglect (i.e., must not have demonstrated neglect for any visual field);
e. any alcohol or substance *dependence* (not just *abuse*) as per DSM-IV diagnostic criteria; or
f. any history of major psychiatric co-morbidity (excluding depression or anxiety).

The study focused only on adults with moderate to severe TBI because it was anticipated that facial affect recognition deficits would be more prevalent after moderate to severe brain injury than after mild injury. The one year post-injury requirement was included to avoid any possibility of recruiting participants with moderate to severe TBI who had recovered emotion recognition skills spontaneously. It should be noted also that people with TBI were not excluded from this study on the basis of co-morbidities such as depression. Given the nature of the injury, depression is often present in this population and a representative feature of clients seen in practices. It is noted that depression (including anti-depressants) might affect emotion recognition performance, so precautions were taken to monitor the levels of depression in participants who had been diagnosed with that disorder.

Participants across the three sites were drawn from facilities that provided brain injury rehabilitation services and support groups. In New Zealand, 54 potential participants were recruited from 2009 to 2011 through five main agencies: the Psychology Clinic at Massey University in Wellington; ABI Rehabilitation, Wellington (formerly Cavit ABI Rehabilitation); the Brain Injury Association of Wellington; Independent Living Rehabilitation Services of Wellington; and the Manawatu Stewart Centre (see CONSORT flowchart in Figure 5 for more details). Two hundred and three people with moderate to severe brain injury were screened for eligibility. Of those, 133 were excluded; 115 did not meet the inclusion criteria at screening, 13 did not meet the inclusion criteria at pre-test, 1 participant declined to participate, 3 were excluded because they were not randomized, and 1 was excluded due to missing data. The final sample, therefore, consisted of 70 participants: of these, 79% were white, 16% black, 1% New Zealand Maori, 1% Hispanic, and 3% of other ethnic backgrounds. The majority of participants sustained their injuries as a result of motor vehicle accidents (64.3%), falls (15.7%), or assaults (8.6%). Ninety-seven percent had injuries that met criteria to be classified as severe in terms of duration of post-traumatic amnesia (greater than seven days). Participants were on average 10.5 years post injury (*SD* = 8.37), and the mean period of education was 12.7 years. See Table 1 for demographic information of participants.

Table 1

Demographic Information of Participants (N = 70)

	Mean / Percentage	SD
Demographics		
Age (years)	40.64	11.04
Gender (%)		
Male	80	
Female	20	
Years of education	12.7	2.45
Race/ethnicity (%)		
White	78.6	
Hispanic	1.4	
Black/African American	15.7	
Maori	1.4	
Other	2.9	
Cause of injury (%)		
MVA-related accident	64	
Fall	15.7	
Assault	8.6	
Other	10	

The 70 participants were randomized, with 23 assigned to receive the *Faces* training, 23 receiving the *Stories* training, and 24 participants assigned to receive the Cognitive training (Control). The *Faces* group consisted of 22 males and 1 female aged between 16 and 61, the *Stories* group of 17 males and 5 females aged between 21 and 60. The Control Group comprised 16 males and 8 females between 24 and 59 years of age. As the randomisation did not block on gender, the random allocation resulted in this non-equal distribution of males and females in each group.

Measures

For the wider clinical trial, participants completed tests assessing a range of domains including visual neglect, understanding of words describing emotions, presence of face processing problem, general reading comprehension, facial affect recognition, vocal affect recognition, emotional inference from social context, cognition, community integration, interpersonal behaviour, empathy, the olfactory area and depression. On the basis of a consensus decision in the wider research team, primary measures and those considered of closest interest were administered before treatment and at all post-treatment assessments. Of these, a subset was administered at both pre-treatment baseline assessments, primarily to examine fulfilment of the selection criteria of the study. Other measures were administered only at pre- and post-treatment, where change over the follow-up period was considered less likely or less relevant to hypotheses, and to manage the demands placed on participants at these assessments. Only material relevant to this dissertation is reported here—Appendix A provides a brief description of the additional measures used in the wider clinical trial. Data entry and scoring for these measures was conducted by a research assistant who had received no information regarding treatment condition.

Main Outcome Measures

The *Diagnostic Analysis of Nonverbal Accuracy–Adult Faces* (DANVA2-Adult Faces; Nowicki & Duke, 1994) test assesses affect recognition from facial expressions, and consists of 24 colour photographs of faces that vary in gender, ethnicity, emotion and emotion intensity. Each photo was presented on a computer screen for 15 seconds, a variation on the standard procedure for this measure, in which presentation time is normally two seconds. The time was changed to minimise the effect on performance of information processing speed and visuoperceptual abilities. It was therefore a conservative test of impairment, since this change may have increased participants' scores relative to the norms. From the four labels referring to emotion that were supplied below the picture, participants were asked to choose the one that best described how the person in the photograph was feeling (happy, sad, angry, or fearful). Test scores ranged from 0 to 24.

The DANVA2-Adult Faces is a widely used form of assessment applying to all races, sexes and ages (Neumann et al., 2012). It has been reported to be a valid and reliable measure of emotion recognition, with an average internal consistency of .88 (N = 1002;

Nowicki, 2010). Test-retest reliability was .81 in a study with persons having TBI (Spell & Frank, 2000) and it has been shown to correlate well with other measures assessing related constructs such as personality and social competence (Nowicki & Carton, 1997; Nowicki & Hartigan, 1988; Riggio, Tucker, & Coffaro, 1989). In the current study, the DANVA2-Adult Faces was administered at all assessment points. The administration of the DANVA2-Adult Faces at both screening and pre-test served two purposes: to establish baseline performance and it was one of two primary outcome measures of this study.

The *Emotional Inference from Stories Test* (EIST) was specifically developed for the current study by Zupan (2009). It is designed to assess a person's ability to infer an emotional state from a social context. It consists of a set of 12 short stories of between 150 and 250 words in length. Each story involves a character in a situation that would lead to a particular emotional response. The stories were presented one at a time on a computer both visually and auditorily. After each story, participants had to answer a question about the character's predominant emotion by choosing from a list of four options: happy, sad, angry, or fearful. This measure had been tested previously on 39 participants with no developmental or neurological disabilities, in order to validate the targeted emotional responses for each story (Zupan, 2009). Participants' agreement ranged from 74% to 100% for stories targeting happy, 72% to 92% for stories targeting sad, 92% to 97% for stories targeting angry, and 84% to 87% for stories targeting fearful. The EIST was administered at all assessment points, and was the second primary outcome measure of the study.

Secondary Outcome Measures

The *Interpersonal Reactivity Index* (IRI; Davis, 1983) is a self-report measure designed to assess emotional and cognitive empathy. It contains a total of 28 items assessing four subtypes of empathy: perspective-taking, empathy concern, fantasy scale and personal distress. Using a 5-point Likert scale, participants are asked to rate how well each item described them. Scores on each of the four subscales can range from 0 to 28, with total empathy scores ranging from 0 to 112. High scores indicate higher levels of empathy. The IRI has been reported to have substantial test-retest reliability and internal reliability (Davis, 1980, 1983). The subscales show satisfactory to high internal consistency (Cronbach's alpha = .69 to .80; Laurent & Hodges, 2009). The IRI has established validity for use in a healthy population (P. L. Jackson, Meltzoff, & Decety,

2005) as well as for individuals suffering from neurological disorders including TBI (de Sousa et al., 2010; Muller et al., 2010; Neumann et al., 2012). Each participant and his/her informant completed the IRI at all assessment points.

The *Neuropsychiatric Inventory* (NPI; Cummings et al., 1994) is a well-established test that evaluates neuropsychiatric symptoms. It covers 12 neuropsychiatric domains: delusions, hallucinations, agitation/aggression, depression, anxiety, apathy, disinhibition, irritability, euphoria, aberrant motor behaviour, sleep disturbances and eating disturbances (Cummings, 1997). This study focused on four domains only: irritability, agitation/aggression, disinhibition and apathy. Pragmatic considerations of time were a factor in deciding not to administer the entire scale.

Each domain has a set of screening questions. Symptom severity is assessed by asking the informant to rate both the frequency (0, not at all; 1, occasionally; 2 often; 3 frequently; 4, very frequently) and severity of symptoms (1, mild; 2, moderate; 3, severe), which produces a composite domain-specific frequency × severity score. The total NPI score for this study was calculated by adding the composite domain-specific severity ratings for the four domains, with higher scores indicating greater overall neuropsychiatric symptom severity. The NPI has been tested for validity and reliability: internal consistency was established (0.75-0.89) for each item/subscale of the NPI (Cummings et al., 1994) and inter-rater reliability was reported to vary from 80% to 100% for the total score (Camozzato et al., 2008; Cummings, 1997). The NPI has been shown to be a reliable and useful tool in assessing patients with dementia (Connor, Sabbagh, & Cummings, 2008), epilepsy (Krishnamoorthy & Trimble, 2008), Parkinson's disease (Aarsland et al., 1999) and traumatic brain injury (Kilmer et al., 2006). The NPI was rated by participants' informants at screening, post-test, and at the three- and six-month follow-ups.

Additional Outcome Measures

The *Facial Affect Naming* (subtest 3) of the Florida Affect Battery (FAB-3 Facial Affect Naming; Bowers et al., 1991) assesses affective labelling for 20 black and white photographs of female faces. The participants' task was to choose the most appropriate label from a list of five emotional descriptors: happy, sad, angry, fearful, or neutral. The test-retest reliability of the FAB ranges from .89 to .97 (Bowers et al., 1991). It has been found to differentiate effectively between performance levels of healthy adults and adults with brain injury (Middleton, 2001). In the current study, the FAB-3 Facial Affect Naming was administered at all assessment points.

The *Community Integration Questionnaire* (CIQ; Willer, Ottenbacher, & Coad, 1994) consists of 15 items linking to three domains: home integration, social integration and productivity. It was developed to address social role limitations and community interaction problems for individuals with acquired brain injury, especially TBI, with higher scores on the CIQ indicating better community integration on the individual’s part. Evidence of instrument validity and reliability in assessment of the TBI population has been amply demonstrated (Saeki, Okazaki, & Hachisuka, 2006; Salter, Foley, Jutai, Bayley, & Teasell, 2008). Test-retest reliability coefficients have ranged from .83 to .97, with concurrent and discriminant validity also well-established (Saeki et al., 2006; Willer et al., 1994 ; Willer, Rosenthal, Kreutzer, Gordon, & Rempel, 1993). The CIQ has been shown, furthermore, to have good internal consistency and test-retest reliability in stroke patients with aphasia (Dalemans, de Witte, Beurskens, van den Heuvel, & Wade, 2010). A recent review by Laxe and colleagues (in press) suggests that the CIQ is one of the most highly regarded measures in clinical studies for TBI, with well-established psychometric properties. The CIQ total score was used to assess participants’ level of community integration, with evaluation obtained from informants at screening, immediately after treatment, and at the three- and six-month follow-ups.

The *Life Stressors and Social Resources Inventory-Adult Form* (LISRES-A; Moos & Moos, 1994) was used to assess participants’ social resources and stressors relationships. This measure is a self-report inventory that covers eight domains of life: physical health, housing and neighbourhood, finances, work, relationship with spouse or partner, relationships with children, relationships with extended family, relationships with friends and with social groups. For the purposes of this study, only the quality of the current relationship between family members and those with TBI was evaluated, with one of the indices drawn from the LISRES-A—the interpersonal stressors and resources subscale. This subscale comprises six items tapping helpful aspects of relationships (e.g. does he or she really understand how you feel about things?), and five tapping stressful aspects of relationships (e.g. is he or she critical or disapproving of you?) For these 11 items, each participant was asked to rate his/her informant on a 5-point scale varying from never (0) to often (4), and the informant is asked to do likewise with regard to the participant. Higher scores indicate a greater number of stressors and greater resources.

The internal consistency of LISRES-A ranges from .77 to .84 for the interpersonal resources domain, and from .85 to .95 for the interpersonal stressor domain (Moos & Moos, 1994). It also has good concurrent and predictive validity (Holahan, Moos, Holahan, Brennan, & Schutte, 2005) and has been commonly used to assess relationship quality among individuals with substance use disorder and brain injury (Moos, Brennan, Schutte, & Moos, 2010; Stancin, Wade, Walz, Yeates, & Taylor, 2010; Tracy, Kelly, & Moos, 2005). The LISRES-A was administered to both participants and their informants at screening, post-test, and at the three- and six-month follow-ups.

The *Cogstate* test battery comprises a set of independent tasks assessing a range of cognitive abilities (CogState Ltd, Melbourne, Australia). For this study, we used the eight tasks that evaluated domains of cognitive function known to be sensitive to cognitive changes following TBI (Maruff et al., 2009). They include indices of verbal learning (International Shopping List Task; ISLT), verbal delayed memory (International Shopping List Task-Delayed Recall; ISLT), speed of processing (Detection Task; DET), attention/vigilance (Identification Task; IDN), visual working memory (One Back Task; ONB), non-verbal learning (Continuous Paired Association Learning Task), executive functioning (Set-Shifting Task) and social cognition (Social-Emotional Cognition Task; SECT). A description of the tasks relating to these cognitive domains is summarised in Appendix B. The validity and reliability of the battery has been established from over 100 peer-reviewed scientific articles (see www.cogstate.com). The CogState battery has been shown to be sensitive to mild cognitive impairments in a variety of disorders including TBI (Darby, Maruff, Collie, & McStephen, 2002; Maruff et al., 2009) and has minimal practice effects (Falleti, Maruff, Collie, & Darby, 2006). CogState has been widely used in clinical studies, as it is reported to be effective at measuring baseline and detecting subtle changes in neurocognitive function and performance (Davison et al., 2011; Dingwall, Maruff, Fredrickson, & Cairney, 2011). The CogState tests were presented at pre-test and post-test only.

The *Beck Depression Inventory* (BDI-II; Beck, Steer, & Brown, 1996) is a widely used 21-item self-report depression screening measure. Each item is rated on a 4-point Likert-type scale (0 to 3), with total scores ranging from 0 to 63, and higher scores indicating even more significant levels of depression. For this study, participants were asked to circle the number beside each statement that best described the way they had been feeling over the previous two weeks. The BDI has excellent internal reliability in both clinical and non-clinical populations, as well as convergent, discriminant and cross-cultural validity (Aalto, Elovainio, Kivimäki, Uutela, & Pirkola, 2012; Nuevo, Lehtinen, Reyna-Liberato, & Ayuso-Mateos, 2009). Its internal consistency has been reported to be around .91 (Dozois & Covin, 2004). The BDI has also been found to be sensitive to persons with traumatic brain injury, displaying a sensitivity of 87% and a specificity of 79% (Homaifar et al., 2009). The BDI was administered at pre-test and three-month follow-up.

Procedure

This study was approved by research ethics committees at all participating institutions, and every participant provided informed consent prior to participation. For the New Zealand site, ethical approval was obtained from the Central Regional Health Disability Ethics Committee. Psychologists, key workers, case managers and other staff from the aforementioned five agencies identified potential clients, who were then approached by either my supervisor or myself, or by a research assistant, with a view to discussion of possible participation in the study. All assessment and treatments were conducted in a quiet room in a university facility, clinic, rehabilitation service, or other suitable location. At the New Zealand site, the assessment and treatments took place either at the Psychology Clinic at Massey University Wellington, or in a quiet room at another location more convenient for and familiar to the participants. In the Palmerston North region, the assessment and treatments were carried out at the Manawatu Stewart Centre.

Recruitment

Prior to the screening assessment, potential participants were advised as to the nature of the study for which they were to give informed written consent. Interested individuals were first screened by telephone for fundamental inclusion criteria. Potential participants who met our basic requirements were then invited for a screening assessment to determine their eligibility for participation. See Appendices C, D and E for the information sheets and Appendix F for the consent form.

Screening

Trained research assistants who had postgraduate degrees in psychology conducted all screening assessments (including pre- and post-test and follow-ups) on an individual basis. On some occasions the assessments were conducted by me or by a research supervisor when a research assistant was unavailable for a particular assessment. The assessor was blind to the treatment assignment of the participant being assessed. As the sole administrator of the three proposed treatments in Wellington, I did not undertake any post-treatment assessments, although I was involved in a small number of screening assessments prior to and independent from participant randomisation to treatment.

Table 2

Assessment Procedure

Participant	Screen	Pre-test	Post-test	3-month follow-up	6-month follow-up
Medical History	•				
Line Cancellation	•				
Emotional Descriptors	•				
CogState Tasks		•	•		
DANVA2-Adult Faces	•	•	•	•	•
DANVA2-Voices	•	•	•	•	•
EIST	•	•	•	•	•
IRI	•	•	•	•	•
LISRES	•		•	•	•
DCT	•		•		
B-SIT A	•				
FAB[1]	•	•	•	•	•
BDI-II		•		•	
Caregiver	**Screen**	**Pre-test**	**Post-test**	**3-month follow-up**	**6-month follow-up**
CIQ	•		•	•	•
NPI	•	•	•	•	•
IRI	•	•	•	•	•
LISRES	•		•	•	•

Note. BDI-II = Beck Depression Inventory-II; B-SIT A= Brief Smell Identification Test version; CIQ= Community Integration Questionnaire; DANVA2= Diagnostic Assessment of Nonverbal Affect; DCT= Discourse Comprehension Test; EIST = Emotional Inference from Stories Test; FAB = Florida Affect Battery; IRI = Interpersonal Reactivity Index; LISRES = Life Stressors and Social Resources Inventory; NPI = Neuropsychiatric Inventory

[1] At screening, three-month follow-up and six-month follow-up, only the Facial Affect Naming, a subtest of the Florida Affect Battery, was administered, as this forms part of the selection criteria for the study. All included FAB subtests were administered at pre-test and post-test.

Table 2 displays the sequence of the assessment procedure. In the first part of the screening assessment, the demographic details and medical histories of potential participants were sought, especially details relating to brain injuries. In the second part, the participants were administered the Line Cancellation Test, the Emotional Descriptors Test, the Discourse Comprehension Test, DANVA2-Adult Faces, FAB-3 Facial Affect Naming, the Diagnostic Analysis of Nonverbal Affect 2-Adult Paralanguage, the Emotional Inference from Stories, the Interpersonal Reactivity Index, the Life Stressors and Social Resources Inventory-Adult Form, and the Brief Smell Identification Test to determine eligibility for participation. Most of these measures were presented either on a desktop or a laptop computer. The DANVA2-Adult Faces and FAB-3 Facial Affect Naming were counterbalanced across participants because of possible order effects resulting from similarity in faces. The vocal affect recognition task, DANVA2-AV, was also counterbalanced. Two versions of the screening form, A and B, were used to effect this counterbalancing assignment. The other measures in this study were not counterbalanced; partly because they were assessing different domains but also because, for the wider team, the time factor was a consideration. The screening session, which took approximately two hours, included short breaks when needed.

Pre-test

Those who met our criteria were given the pre-test assessment within 15 to 28 days after the initial screening (the delay would allow time to control for the possibility of practice effects). 76.5% of pre-test assessments were completed within an average of 22 days after screening. Completion of 23.5% occurred, however, outside the intended window (11.75% falling at 1 to 7 days beyond, another 11.75% at 22 to 30 days) mainly because some participants were away on holiday or out of town. One participant completed the pre-test assessment more than 120 days after screening and was therefore excluded as an outlier. The pre-test assessment included the CogState, DANVA2-Adult Faces, FAB-3 Facial Affect Naming, the DANVA2-Adult Paralanguage, the Interpersonal Reactivity Index, the Emotional Inference from Stories, the Life Stressors and Social Resources, the Beck Depression Inventory, the Brief Smell Identification Test, and the Florida Affect Battery – subtests 1, 8b and 9. In the case of the DANVA2-Adult Faces, inclusion criteria for facial affect recognition were re-assessed by the research assistant to ensure that a participant was still eligible after the pre-test assessment.

Participants' informants were also asked to complete several questionnaires (i.e., the Neuropsychiatric Inventory, the Interpersonal Reactivity Index, the Life Stressors and Social Resources, and the Community Integration Questionnaire) during each assessment point to evaluate the participant's level of personal functioning, social functioning and community integration.[2] Spouses, family members, support key workers or close friends were nominated by participants for the role. We included informants' ratings in the study's design as persons with TBI may manifest memory deficits limiting their ability to reliably self-report. Obtaining collateral information from informants can also provide some clinical information about the generalisation of treatment effects to participants' everyday behaviour. Informants were instructed to return the completed questionnaires to the researchers by post or email. Those who did not return them within a stipulated time were contacted either in writing (including email) or by telephone to encourage completion of the rating scales.[3]

Randomisation

Once it had been determined that the participants were eligible to participate in the study, they were randomly allocated after baseline assessment to one of the three intervention groups referred to earlier. *Faces* aimed to teach people how to read emotions as conveyed in facial expressions, while *Stories* focused on teaching how to infer emotion-related information from context. The control group engaged in cognitive training activities that were not thought to alter affect recognition abilities. Participants were not informed that they had been assigned to treatment or control conditions; individuals in the three groups, however, were told that the aim of the study was to determine whether participation in the three new training programmes improved cognition and emotion skills.

Randomisation was carried out by means of a computer-generated list prepared by a statistician. In order to ensure that approximately equal numbers of participants were allocated to each treatment condition at all times in the course of the research period,

---

[2] At all three sites, we unfortunately failed to collect the socio-demographic details relating to participants' informants. For that reason, comparison of the informants across the three treatment groups could not be made for this dissertation.

[3] In the New Zealand site, several participants had nominated new informants at some testing stages instead of the originally chosen informant as they reported that the latter no longer saw them on a regular basis. The research team was aware of this and agreed to any changes, since it was important for informants to have regular contact with the participants. We noted changes in the informant statutes.

groupings of three were used for the process.[4] Each intervention was delivered on an individual basis for one hour, three times weekly over a three-week period: I conducted all the training sessions as a doctoral-level clinical psychology trainee. The training followed information in a detailed manual describing the sequence and content of specific treatment components. I received a substantial level of training in delivery of such programmes from the primary research supervisor, a consultant clinical psychologist, and – at an obviously greater distance – from the training programme authors at the other two study sites.[5]

Intervention

Radice-Neumann et al. (2009) describes the pilot study that tested the precursor version of the *Faces* and *Stories* interventions. These two training approaches were developed partly from treatments for people with autism, who in some ways have similar emotion recognition difficulties to individuals with TBI (Baron-Cohen et al., 2009). The emotional stimuli in the *Faces* and *Stories* interventions focused only on four basic emotions (happiness, anger, sadness, fear). The treatment manuals describing the treatment protocols and procedures for the two interventions and the control are obtainable from the lead author of that paper on request. Appendices G and H provide the treatment manuals for *Faces* and *Stories* interventions.

Faces intervention

The *Faces* intervention is a computerised training programme designed to improve facial affect recognition. It consists of seven training exercises that address two components: one teaching participants to attend to specific emotional facial features (facial-feature processing), while another focuses on increasing emotional self-awareness (self-emotional processing). In the first component of the *Faces* training, participants were presented with 40 faces displaying different kinds of emotion, and varied in terms of gender, emotional intensity and race (Appendix I). Participants view these faces—developed and standardized by Gur and colleagues (2002)—on a computer screen and are taught by means of strategies such as repetition, vanishing cues, feedback and procedural learning, to concentrate on specific features of each face. Visual cues

[4] For each group of three participants, the first was randomly assigned to one of the three treatment conditions (Faces, Stories, Control group). The second was randomly assigned to one of the two remaining groups. The third participant was automatically assigned to the final remaining group.
[5] On one occasion, a principal investigator from the St Catharines site and my research supervisor watched from behind a one-way mirror as I conducted a treatment session with a participant.

were used at the outset, for example, to highlight the relevant facial features, but these are gradually withdrawn or “vanished” throughout each training session. Feedback was provided for each trial. Following incorrect answers, additional cues were displayed on the computer that described the characteristics of the features and emotion being expressed. For example, “The eyes are wide open. The mouth is slack. This person is fearful.” (Radice-Neumann et al., 2009). For each face stimulus, participants had to identify the emotions conveyed. Additional requirements were gradually introduced, including discussion of personal emotion-laden events or imitation of the facial expressions. The first two exercises of the training were relatively easy, since only obvious facial expressions had to be identified. The remaining exercises presented greater challenge because they progressed to more subtle facial expressions.

After completing the first component of the *Faces* training, the therapist chose eight emotional events described by the participant for further discussion in the second component (Appendix J). Here participants were asked to recall and describe personal experiences that corresponded to specific emotions, and then to mimic that facial affect using a mirror. They were also required to describe the physical and physiological changes of the body they thought would be associated with each emotion (for example, sad is associated with heaviness in the chest, arms, and legs, and with tightness in the throat and eyes). Both emotional experience and mimicry are thought to play a facilitating role in emotion recognition.

For each of the eight emotion-related events, participants were asked to describe the following:

1. details of the event,
2. what led up to it,
3. how the event made them feel (the physical/physiological changes they felt at the time of the event were also elicited),
4. why they felt the way they did,
5. how they responded, and
6. the consequences of the event and their response to it.

For each training exercise, participants had to obtain at least an average score of 85% (i.e., by answering 30 out of 35 questions in the first training exercise) in order to move on to the next training level. This was chosen as a training criterion, since a person must achieve approximately 85% accuracy on the DANVA2-Adult Faces to perform within the “normal” range. Those who failed to obtain 85% accuracy were required to repeat the exercise. If a participant did not reach this score on the second attempt, he or she had to repeat the exercise at the next training session.

Stories intervention

The *Stories* training is aimed at improving social context processing and at facilitating internal emotional processing. It derived from the ideas of social stories, which are often used as treatment for persons with social perceptual deficits. The *Stories* training consisted of 15 short stories incorporating two strategies: attention to contextual cues reflecting emotion (e.g. wants, expectations, and behaviours), and relating the story to events in their own lives (Appendix K). Similarly to the *Faces* intervention, the emotional inference stories were presented to participants both visually and orally on the computer so that they could read the text of each story while listening to it. For each story, there were five questions which equally addressed the four emotions (happy, sad, angry, and fearful). Text within the body of the story was colour coordinated with the questions, and key words were presented in bold to draw participants’ attention to pertinent information. These cues highlighted characters’ wants, expectations and behaviours. The coloured text and words in bold were gradually removed over time. To compensate for memory limitations, questions were “hyperlinked” to the relevant area of the story so that the participant might reread the relevant information easily. Before answering each question, participants were encouraged to reread the relevant section of the story and then to choose the strongest emotion they believed the character was experiencing. For incorrect responses, feedback was provided through a “pop-up” message with correct responses, along with a summary of relevant context and the correct emotion. Whatever the accuracy or otherwise of their choice, participants were asked why they had chosen as they had, and what key words they had used in making their decisions. After the correct response had been discussed, participants were asked the following questions to help them relate to the emotion intrinsic to the situation:

1. Has anything similar ever happened to you? If so, please describe.
2. How would you have felt in this situation (or how did you feel in your similar situation)?
3. Why did (or would) you feel that way?
4. How did (or would) you respond in the event?

5. What was (or what do you think) would be the outcome of the event?
6. How do you think the event or your actions caused (or would cause) others to feel?
7. What makes you think they felt (or would feel) that way?

Throughout the training, participants were taught that events consistent with a person's beliefs and wants would elicit a positive emotion, while ones that were inconsistent would elicit a negative emotion. Participants had to achieve an average score of 80% for each story (answering at least four out of five questions correctly). If they did not succeed in this, they had to repeat that story on the next training session before proceeding to the next story.

Control Group

The control intervention focused on training cognitive skills (non-social) and simulations of skills for daily living which did not involve any emotional component (Appendix L). In order to ensure that the improvement in the *Faces* and *Stories* groups was due to the treatments and not merely to interpersonal interaction with the therapist, participants in the control group received a 'sham intervention' that provided sessions matched to the other two groups in terms of number of sessions and session duration, and also in the amount of attention given by the therapist. The basic structure of the sessions was likewise similar—working one-on-one with a therapist in a computer-based intervention activity. In the control group, the participants engaged in a wide range of computerised cognitive exercises such as memory skills, maths skills, career skills and functional skills. These computerised training exercises were carefully selected from three internet sites to target various cognitive skills.[6] The GCF LearnFree.org website offers many life skills activities for four major areas: everyday life; math and money; workplace and career; and computer skills. The Cognitive Labs and the Brain Ball websites, on the other hand, provide various games and exercises to improve different aspects of cognition. Participants in the control group did not know that they were part of the control intervention—they were under the impression that they were simply completing a different training regimen from the other treatment. Anecdotally, many participants in the control group were clearly energised and

[6] The three internet sites of the computerised training exercises included GCF LearnFree.org (http://www.gcflearnfree.org), Cognitive Labs (http://cognitivelabs.com/gamelist.htm), and the Brain Ball (http://playwithyourmind.com/brain-games/wordball.

motivated for the treatment they were receiving, and reported it was benefitting them—suggesting a robust treatment control had been created.

To ensure that no participants were denied potentially beneficial treatment, participants in the control (and in the other two treatment groups) were informed that at the conclusion of the study they would be offered the most effective intervention at no charge if another type of treatment was found in the trial to be more effective in addressing their emotion recognition difficulties.

Post-test

Participants were post-tested within four days of completion of all training sessions. The materials and procedures for the post-tests were identical to those of the pre-test. Finally, follow-up data were collected three, then again six months after the conclusion of the intervention. It was obtained by the participants' return to the clinic or to a designated location for test sessions, and also by their informants' completion of the required questionnaires.

Each participant was paid a small amount per assessment session (and at some sites, also for treatment sessions) in partial recognition of travel expenses and effort—exact payment amounts varied across sites, associated with local budgets, ethical review board policies, and the geographical range potential participants might be travelling, but all were in the order of US$10–$15 per session.

Planned Statistical Analyses

It was planned that for those variables assessed in both the screening and pre-test, the mean of two time points would be used as a baseline score. The two pre-assessments (i.e., screening and pre-test) were to be conducted to ensure a stable baseline for the key outcome variables. For other variables assessed in either screening or pre-test, the mean of that time point would be used as the pre-test score. I planned both to examine data for outliers and to determine the data distribution. Baseline differences in demographic and clinical variables would be compared across groups, using one way analysis of variance (ANOVA) for continuous variables and the Chi-square (or Fisher exact) test for categorical variables. To account for any between-group potential difference at pre-treatment, I planned to use a series of ANOVA for each variable of interest (e.g. affect recognition, empathy, social functioning, cognition, depression measures)

To evaluate the effectiveness of the two interventions, I planned to use a general linear model (GLM) repeated-measures ANCOVA design to analyse the outcome measures. The between factor would be the treatment group (Faces versus Control, and separately Stories versus Control) and the within factor would be the time (post-test, three-month follow-up, six-month follow-up). Baseline scores for each repeated-measure ANCOVA would be used as covariates. Controlling for baseline status in ANCOVAs provides an effective analytic approach in establishing intervention effects in a clinical controlled trial as this minimises the possibility of error variance (Field, 2009; Loh, 2009; Raush, Maxwell, & Kelley, 2003). A consultation with Dr Jim Malec by our wider team also echoed the same view. Borm, Fransen and Lemmens (2007) suggest that controlling for the baseline score is superior to simple pre-post comparisons and usually requires fewer participants. For all the ANCOVA analyses, I planned to carry out separate comparisons of the *Faces* group and the *Stories* group with the Control group. The *Faces* training would not be compared with the *Stories* training because each was designed to target particular aspects of affect recognition; nor was it the goal of the wider study to compare the relative merits of the two treatments. I planned to assess the main effects of time, groups, and interactions between treatment groups on changes over the three post-treatment time points. It was planned that in the case of significant main effects or interactions, pairwise comparisons ANCOVAs would be used. Effect sizes would be calculated using partial eta squared (η_p^2), which is said to be sensitive to various kinds of linear and nonlinear relationships. Values ranging from 0.01 to 0.06 indicate small, values from 0.06 to 0.25 medium, and values above 0.25 large effect sizes (Cohen, 1988).

Analyses of the outcome measures would be performed according to the intention-to-treat approach. As will be indicated, missing data is a common impediment in clinical research (A. M. Wood, White, & Thompson, 2004). Of the 70 participants who had completed the treatment in the current study, 15 had missing data for at least one post-treatment assessment points (post-test, three-month follow-up, six-month follow-up), leaving 55 participants with complete data at all five assessment points (it should be noted, however, that one of these participants had only four assessment points). For the primary outcome variables used in the analyses to be reported, missing participant-related data across the three post-treatment assessments varied from 7.3% to 22% (the extent of the missing values for each of the primary outcome measures is summarized in Table 3).

Table 3

Percentage (%) of Missing Data by Variable at Each Time Point for Participants

	Pre-test	Post-test	3-month	6-month
Primary Outcome Measures				
DANVA2-AF	-	7.4	15.7	21
FAB-3	-	7.4	15.7	21
EIST	-	7.4	15.7	21
IRI	-	7.4	15.7	21
LISRES-A (stress)	-	7.4	22	21
LISRES-A (support)	-	7.4	22	21
BDI	4.3		20.8	
Other Outcomes				
CogState				
Non-verbal memory	4	30		
Attention	4	30		
Woking memory	4	31		
Executive functioning	35	65		
Speed of processing	4	28.5		
Verbal learning	4	28.5		
Verbal delayed memory	4	30		
Social cognition	4	30		

Note. - = *Complete data,* DANVA2-Adult Faces = Diagnostic Analysis of Nonverbal Accuracy 2-Adult Faces, FAB-3 = The Facial Affect Naming (subtest) of the Florida Affect Battery, EIST = Emotional Inference from Stories Test, IRI = Interpersonal Reactivity Index, LISRES-A Stressor and Support = Life Stressors and Social Resources Inventory-Adult Form (Interpersonal domain), BDI = Beck Depression Inventory.

The data missing was attributable mainly to a failure to complete the follow-up assessments after training. The missing data for the secondary outcome measures ranged from 4.3% to 20.8% for the Beck Depression Inventory (pre-test and three month follow-up assessments) and was between 4% and 35% for the Cogstate (pre-test and post-test assessments) with the exception of executive functioning where it was as high as 65% (the data missing for the Beck Depression Inventory were a result of failure to complete the follow-up assessments; and in the case of the CogState, due mainly to difficulty in completing the required tasks and to technical problems linking to executive functioning). The missing data relating to informants for participants varied from 4.2% to 70% across all outcome measures at all assessment points (the Neuropsychiatric Inventory had the highest proportion). Its absence could be attributed for the most part either to the failure of informants to return the questionnaires or to their non-response to certain items in these. Given the high missing data in the Neuropsychiatric Inventory, this test was excluded from the analysis after consultation with my supervisor.

It was planned that missing data would be addressed with multiple imputation procedures in SPSS[7], which rely on the assumption that the data is missing at random (Schafer, 1999; Schafer & Graham, 2002).[8] This statistical technique was chosen because it has been described as the preferred method for reduction of potential bias and uncertainty created from missing data (Schafer & Graham, 2002; Schlomer, Bauman, & Card, 2010). It offers several advantages over listwise deletion such as increased power to detect significant effects and decreased sampling bias. The use of multiple imputation has been shown to perform well with both longitudinal data and small samples. Multiple imputation technique takes the missing data uncertainty into account by generating possible values for missing values, thus creating several "complete" sets of data. Application of the techniques requires three steps: imputation, analysis, and pooling (McCleary, 2002). In the present study, the variables containing the missing data were imputed using SPSS multiple imputation function (via the multiple regression method). The SPSS default setting of five imputations would be used. I planned to use the imputed dataset for all analysis and report the pooled results. Because SPSS reports pooled results for only a limited range of analyses, for analyses without the pooled estimates, I planned to use the average from the five datasets, as suggested by J, Reece (personal communication, September 25, 2012).[9] Although other software packages such as R and SAS are capable of providing formally pooled estimates and statistics for some of the statistics where SPSS cannot, rerunning analyses in these other packages

[7] An imputation dataset was created by my primary supervisor for the wider team. We discussed at length the mechanisms for using this dataset to agree on the analysis approach that I would take to the data in the current study. Although I was not fully involved in the imputation process, my supervisor provided guidance, and taught me the statistical procedure for conducting the imputation. I carried out the analyses for this dissertation personally, using the imputed data.

[8] Because of the significant amount of missing data concerning participants' informants, imputation would not have been an adequate means of addressing the missing values. After discussion of the matter with my research supervisor, it was decided that either a pairwise or listwise deletion method would be more appropriate.

[9] Dr John Reece is a senior lecturer at RMIT University, Melbourne, Australia. In his recent article "A randomised controlled trial of a social support intervention", he reports the results based on the average values of the five imputed datasets.

was beyond the scope of my dissertation research.[10] All statistical tests were two-tailed and an alpha level of .05 was applied. It was planned that all the data would be examined using SPSS software, version 20 for Windows (IBM Corporation, Somers, NY, USA).

[10] The investigators in the wider team, however, will be examining the possibility of doing so.

Chapter 7: Study One Results

"For the first time, I saw everybody else just sitting there and relaxing, and I felt that way because I was happy and content that I could actually see people. They were sitting there, they had smiles on their faces and they were chatting and that made me feel that way. I was very happy to be there. For the first time I did not get into trouble…."

Stories group participant

Baseline Differences

Figure 4 displays the Consort diagram showing the participant flow in the course of the study. The chi-square and one-way analysis of variance (ANOVA) revealed that at baseline, participants assigned to the three treatment conditions did not differ on the demographic and clinical characteristics (e.g. age, education level, ethnicity, injury severity; see Table 4). In terms of gender, $X^2 = 6.2$, $p = .040$, the control group included a greater number of females (33%) than either the *Stories* group (22%) or, more particularly, the *Faces* group (4%). In addition to contradictory findings regarding the effects of gender on affect recognition, there is a lack of evidence indicating that gender is an important predictor of treatment response to affect recognition. Given this, gender was not entered as a covariate in the analyses even though it is noted that there was a significant difference between the groups in terms of gender.

A series of one-way ANOVAs conducted on the primary and secondary outcome measures, as presented in Table 5, showed no between-group differences in pre-treatment levels of facial affect recognition (DANVA2-Adult Faces, FAB-3 Facial Affect Naming), emotional inference from social context (EIST), empathy (IRI), interpersonal functioning (LISRES-A), community integration (CIQ), cognitive functioning (CogState) or depression (BDI). All these indicate that the three groups were generally well-matched before receiving the treatment interventions. Given that there were no significant differences between the groups in the cognitive functioning and depression measures at pre-test, neither of these variables was entered as a covariate in subsequent analyses.

Table 4

Comparison of Participant Characteristics

Variable	Faces (n =23)	Stories (n= 23)	Control (n=24)	Statistic	*p* value
Demographics					
Age in years (SD)	41 (11.7)	41.5 (11.6)	39.5 (10.3)	*F* = .21	.91
Male (n=56)	22	18	16		
Female (n=16)	1	5	8	X^2 = 6.23	.04
Education in years (SD)	12.3 (1.7)	13.2 (2.8)	12.63 (2.7)	*F* = 0.69	.51
Race/ethnicity				X^2 = 5.97	.65
White	20	18	17		
Hispanic	0	1	0		
Black	3	3	5		
Maori	0	0	1		
Other	0	1	1		
Current marital status				X^2 = 9.73	.47
Single	11	9	17		
Partner	2	3	1		
Married/de facto	8	7	4		
Separated/divorced	1	3	1		
Widowed/widower	0	1	1		
Other	1				
Current living status				X^2 = 10.23	.57
Independent	5	3	8		
Living with partner	8	8	4		
Flatmate(s), no support	0	0	1		
Alone, with support	0	2	1		
Flatmate(s), with support	0	0	0		
Group home	0	1	1		
Living with parents	10	18	8		
Rehabilitation facility	0	1	1		
Current work hours (n= 69)	11 (23.8)	6.8 (12.97)	7.8 (21.5)	*F* = 0.28	.76
Time since injury (years)	10.79 (10.2)	10.87 (7.5)	9.82 (7.4)	*F* = 0.11	.89
Injury severity					
PTA (days)				X^2 = 2.11	.35
1-6d	1	2	0		
>7d	18	17	19		
LOA (days)	38 (43.52)	72.64 (81.2)	100.7 (118.7)	X^2 = 1.43	.26
GCS score				X^2 = 4.49	.34
<8	5	8	8		
9-12	2	0	2		
>13	0	0	0		
Cause of injury (n=69)				X^2 = 8.02	.24
MVA	10	18	17		
Fall	7	1	3		
Assault	2	2	2		
Other	3	2	2		

Note. Values are frequency counts unless otherwise specified. PTA = post-traumatic amnesia; LOA = loss of consciousness; GCS = Glasgow Coma Scale; MVA = motor vehicle accident

Figure 5 displays the Consort diagram showing the informants flow in the course of the study. For the informants, one-way ANOVAs were also carried out to test whether there were differences across the three groups in terms of pre-treatment outcome measures.[11]

[11] As information on socio-demographic characteristics of informants were not collected, differences between these groups cannot be examined.

As can be seen in Table 6, informants did not differ at pre-test with respect to the CIQ, LISRES-A and IRI scores (all *ps* > .05). Figure 6 displays the Consort diagram showing participants in the course of the study at the New Zealand site.

Table 5

One way ANOVA for Comparing Three Treatment Groups on Outcome Measures at Baseline

Variable	Faces (n =23)	Stories (n= 23)	Control (n=24)	F	*P* value
Primary outcome measures at baseline	Mean (SD)	Mean (SD)	Mean (SD)		
DANVA2-Adult Faces	13.35 (2.38)	13.98 (2.17)	13.17(2.33)	0.81	.45
FAB-3 Facial Affect Naming	14.41 (2.84)	14.00 (2.73)	14.25(2.08)	0.15	.86
EIST	7.28 (2.22)	7.98 (2.40)	7.77 (2.22)	0.57	.57
IRI	58.67(15.40)	64.04 (13.05)	56.71(12.98)	1.76	.18
LISRES-A Stressor	14.57 (5.04)	13.83 (5.08)	12.79(4.71)	0.77	.50
LSRES-A Support	23.43 (3.19)	23.57 (5.32)	24.00(4.33)	0.11	.90
Secondary outcome measures at baseline					
CogState composite score	.067 (0.50)	.011 (.57)	-0.29 (0.15)	2.12	.13
BDI	15.91 (12.80)	15.96 (9.96)	12.58(10.49)	0.71	.49

Note. DANVA2-Adult Faces = Diagnostic Analysis of Nonverbal Accuracy 2-Adult Faces, FAB-3 = The Facial Affect Naming (subtest) of the Florida Affect Battery, EIST = Emotional Inference from Stories Test, IRI = Interpersonal Reactivity Index, LISRES-A Stressor and Support = Life Stressors and Social Resources Inventory-Adult Form (Interpersonal domain), BDI = Beck Depression Inventory.

Table 6

One Way ANOVA for Comparing the Informants across the Three Groups on Outcome Measures at Baseline

Variable	Faces (n =21)	Stories (n= 23)	Control (n=23)	F	*P* value
Primary outcome measures at baseline	Mean (SD)	Mean (SD)	Mean (SD)		
IRI	49.43 (12.23)	46.76 (19.04)	43.48 (15.65)	0.81	.45
LISRES-A Stressor	13.67 (5.28)	13.96 (5.18)	16 (5.50)	1.29	.28
LSRES-A Support	20.43 (1.22)	19.22 (5.62)	21 (1.51)	0.49	.61
CIQ	12.70 (6.18)	14.78 (4.47)	13.87 (4.53)	0.92	.40

Note. IRI = Interpersonal Reactivity Index, LISRES-A Stressor and Support = Life Stressors and Social Resources Inventory-Adult Form (Interpersonal domain), CIQ = Community Integration Questionnaire.

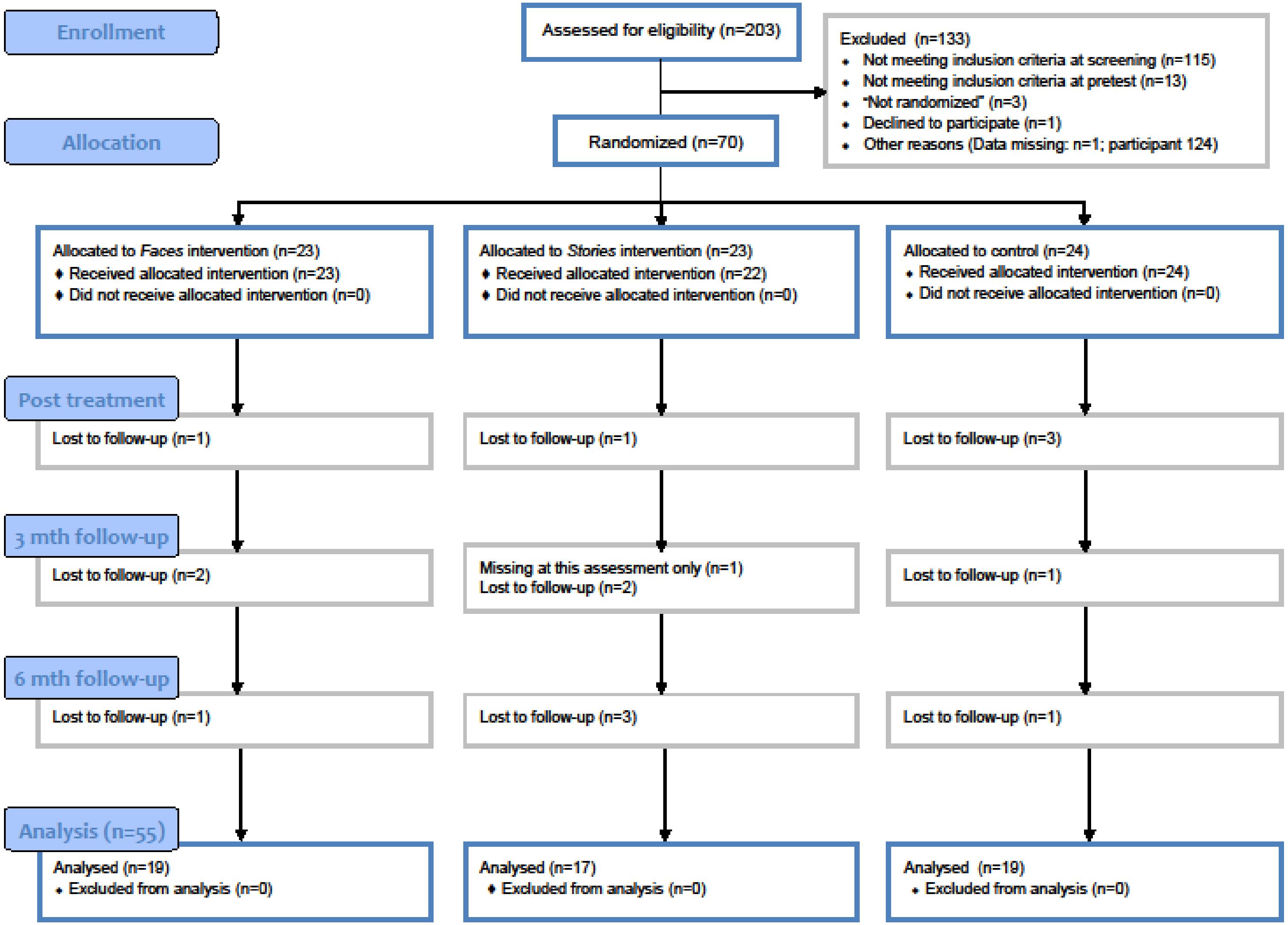


Figure 4. CONSORT flow diagram of participants through the randomised trial.

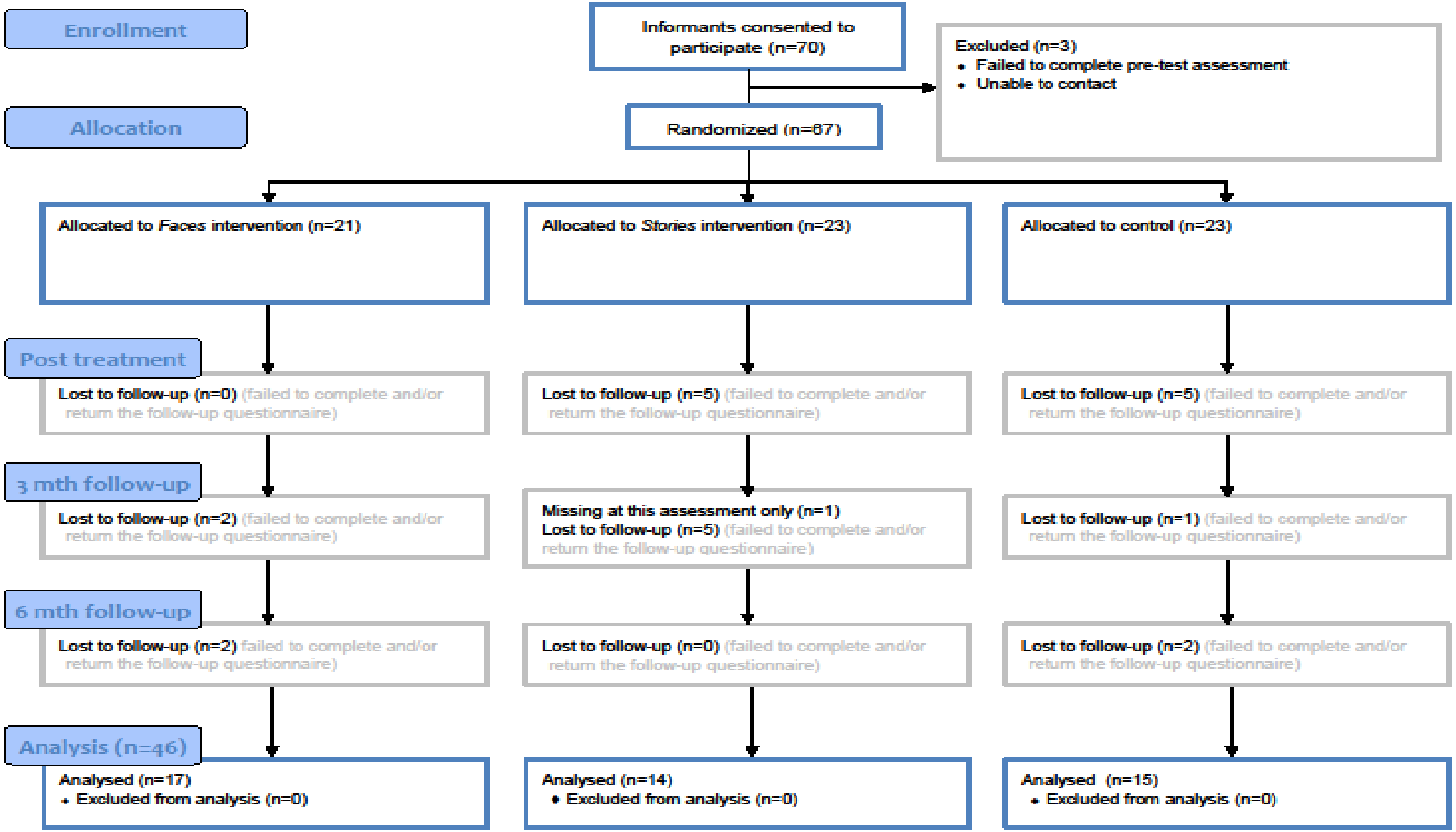


Figure 5. CONSORT flow diagram of informants through the randomised trial.

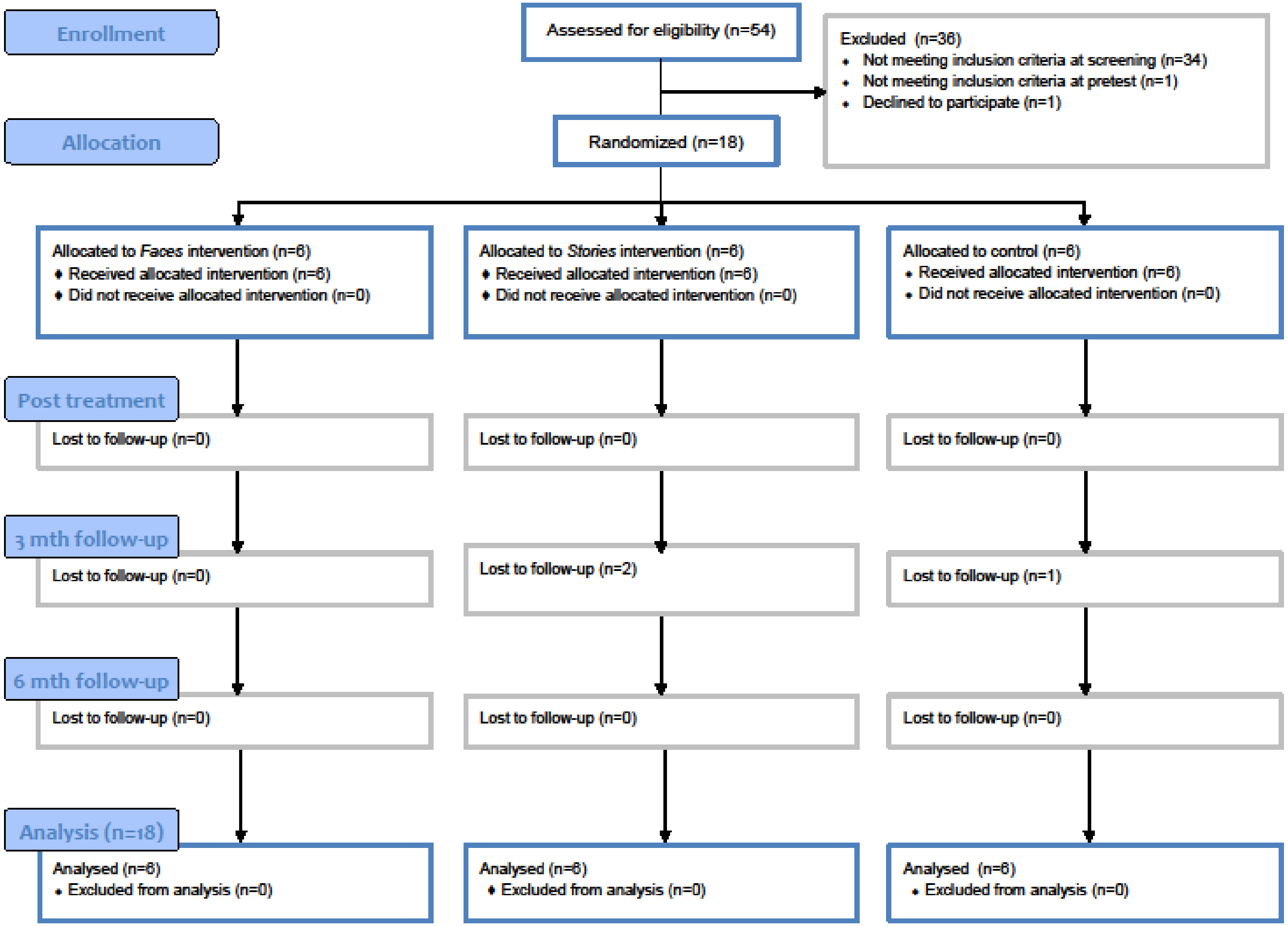


Figure 6. CONSORT flow diagram of participants through the randomised trial (at the New Zealand site).

Attrition

All 70 participants completed the nine training sessions. After the treatment, however (i.e., within the three post-treatment time points), four participants dropped out of the *Faces* group and five and six respectively out of the *Stories* and control groups. The dropouts were mainly due to failure to turn up for follow-up assessment (more details are provided in Figure 4).[12] In total, at six-month follow-up, the cumulative dropouts from the trial accounted for 21% of participants, resulting in a final retention of 79%. Independent t-tests were performed to compare baseline demographic characteristics and primary outcome measures between those who completed all follow-up assessments and those who had dropped out at any point prior to six-month follow-up assessment. No significant differences were found between the two groups on any socio-demographic or baseline measures (all *ps* > .05).

Sixty-seven out of 70 informants completed all the measures at pre-test (*Faces*, 21; *Stories*; 23; control, 23). Of the 67, 10 dropped out at post-test, 13 at three-month follow-up and 21 at six-month follow-up (*Faces*, 4; *Stories*, 9; control, 8)—in all cases through failure to return the relevant questionnaires (see Figure 5). We did not systemically obtain the reasons for these dropouts and some informants did not respond to our attempts to contact them. In total, at six-month follow-up, the percentage of dropouts from the study was 34%. As revealed by independent t-tests, at six-month follow-up assessment the informants who had completed all measures did not differ significantly from the dropouts in their baseline reporting of empathy, interpersonal and social functioning (all *ps* > .05).

[12] Participant CONSORT diagram prepared by Duncan Babbage for the research team. Informant CONSORT and Participant CONSORT diagrams (at New Zealand site) prepared by Jackki Yim.

Facial Affect Recognition

The first set of analyses investigated whether treatment led to significant changes in performance in facial affect recognition.

Faces versus control

Table 7 and 8 show means, standard deviations, difference, and comparison scores. A 2 × 3 (Group × Session) Repeated Measures ANCOVA was performed on the DANVA2-Adult Faces total scores to examine whether, across the three post-treatment time points, participants in the *Faces* group showed greater improvement in facial affect recognition skills than those in the control condition did. The results of the performance on the DANVA2-Adult Faces over time of the three treatment groups are detailed in Figure 7 and 8. (Estimated marginal means are presented as the most appropriate comparison between groups when comparing means of unequal sample sizes.) There was a significant main effect of group, $F(1, 44) = 5.57$, $p = .03$, $\eta_p^2 = 0.11$. Pairwise comparison further revealed that across the three post-treatment time points those in the *Faces* group had higher mean DANVA2-Adult Faces scores than those in the control group (adjusted mean differences = 1.90, $p = .03$, 95% CI [.24, 3.51]). This indicates that the effectiveness of the treatment depended on the type of training received. No significant main effect of time, $F(1.78, 78.1) = 2.73$, $p = .08$, $\eta_p^2 = 0.06$ or of group by time interaction, $F(1.78, 78.1) = 1.36$, $p = .42$, $\eta_p^2 = 0.003$ was found, however.

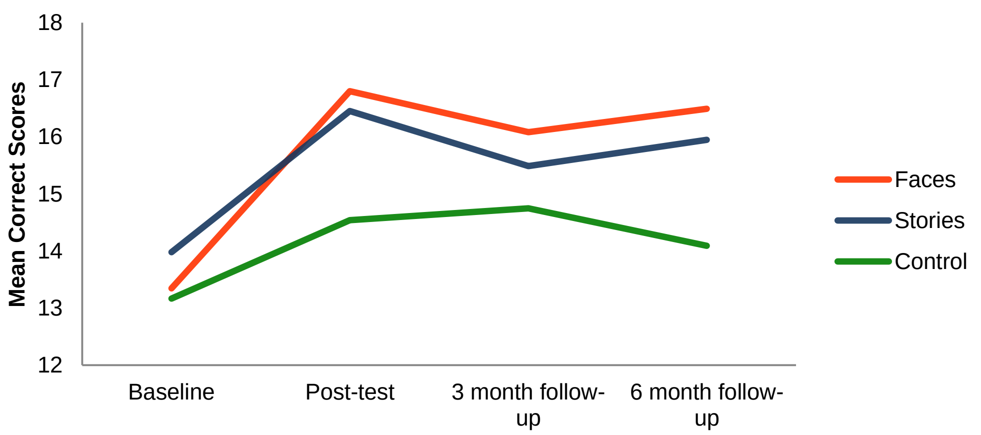


Figure 7. Estimated marginal mean scores at each time point for the DANVA2-Adult Faces total correct responses of the three treatment groups.

As a follow-up to the group effects, a series of one-way between-group ANCOVAs on the DANVA2-Adult Faces total scores indicated that the mean difference between the *Faces* and control groups in the post-test assessment approached but did not reach significance, $F(1, 44) = 4.90$, $p = .05$, $\eta_p^2 = 0.10$. Similarly, the two groups did not differ significantly at the three-month follow-up, $F(1, 44) = 1.83$, $p = .33$, $\eta_p^2 = 0.04$. However, the two groups differed significantly at the six-month follow-up assessment, $F(1, 44) = 7.92$, $p = .001$, $\eta_p^2 = 0.15$.

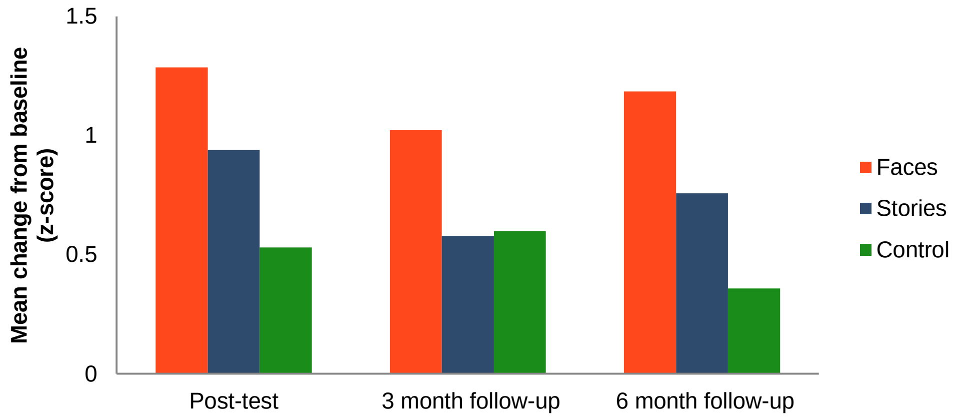


Figure 8. Mean change in z-scores for DANVA2-Adult Faces from baseline to post-test, from baseline to three months, and from baseline to six months according to treatment group. The DANVA2-Adult Faces raw scores are converted to z-scores based on published normative data. DANVA2-Adult Faces = Diagnostic Analysis of Nonverbal Accuracy 2—Adult Faces.

Further analyses using paired t-tests to evaluate within-group changes showed highly significant improvements in the DANVA2-Adult Faces scores for the *Faces* group—but not the control group—from baseline to post-test, $t(22) = 4.95$, $p < .001$ at three-month follow-up, $t(22) = 3.34$, $p = .001$, and six-month follow-up, $t(22) = 4.95$, $p < .001$. These findings suggest that there was sustained improvement and that the initial improvements were maintained over time for participants who received the *Faces* training. The effect sizes for these changes were 0.49, 0.37, and 0.53, with changes in treatment effect size largest at six-month follow-up. The changes correspond to a very large effect size. In the Stories group, the paired t-tests analyses showed that the participants in this group improved significantly only from pre-test to post-test (the effect size for this change was 0.48). This suggests that the initial treatment gains were not maintained over time.

Table 7

Faces and Control Group Mean Scores on Outcome Measures and Repeated Measures ANCOVA Results

	Faces				Control				Difference		
	Baseline Mean (SD)	Post-test Mean (SD)	3 month Mean (SD)	6 month Mean (SD)	Baseline Mean (SD)	Post-test Mean (SD)	3 month Mean (SD)	6 month Mean (SD)	Time F (p)	Group F (p)	Group × Time F(p)
Outcome for Participants											
DANVA2-AF	13.35 (2.38)	16.80 (3.22)	16.08 (3.61)	16.49 (2.97)	13.17 (2.33)	14.54 (3.80)	14.75 (4.06)	14.09 (3.55)	2.73 (.08)	5.57(.03)	1.36 (.42)
FAB-3	14.41(2.84)	16.01(2.74)	15.84 (2.94)	15.69 (3.10)	14.25 (2.08)	15.12 (3.05)	15.33 (2.62)	15.60 (2.46)	0.56 (.60)	0.49 (.52)	1.36 (.47)
EIST	7.28 (2.22)	8.72 (2.48)	8.69 (2.98)	8.18 (3.06)	7.77 (2.22)	8.88 (1.91)	8.28 (2.61)	7.41 (3.19)	3.44 (.09)	1.55 (.23)	1.50 (.36)
IRI	58.67 (15.40)	56.40 (16.37)	57.32 (15.98)	59.21 (15.47)	56.70 (12.98)	54.41 (16.21)	58.10 (16.72)	58.44 (18.43)	0.50 (.61)	0.04 (.51)	0.35 (.68)
LISRES-A (stress)	14.57 (5.04)	14.48 (4.65)	13.80 (4.42)	14.86 (5.33)	12.79 (4.71)	13.13 (4.81)	11.04 (4.21)	10.94 (3.98)	0.27 (.80)	4.65 (.06)	2.68 (.15)
LISRES-A (support)	23.43 (3.19)	23.02 (3.45)	22.47 (3.93)	22.33 (3.66)	24.00 (4.33)	22.75 (5.49)	22.80 (6.09)	23.20 (5.64)	0.45 (.72)	0.15 (.75)	0.56 (.52)
BDI	15.91 (12.78)		16.58 (10.98)		12.58 (10.49)		8.95 (8.33)			2.95 (.10)	
Outcome for Informants											
IRI	49.43 (12.23)	54.95 (18.68)	54.21 (16.69)	49.47 (16.89)	43.48 (15.65)	41.39 (17.46)	43.12 (17.54)	41.67 (15.69)	0.70 (.70)	3.40 (.07)	0.26 (.77)
LISRES-A (stress)	13.67 (5.28)	12.76 (4.90)	13.26 (4.69)	14.12 (4.54)	16.00 (5.50)	13.76 (4.42)	11.65 (4.50)	13.33 (5.01)	1.04 (.36)	0.84 (.37)	2.36(.11)
LISRES-A (support)	20.43 (5.59)	20.67 (5.36)	21.47 (6.24)	20.82 (5.47)	21.00 (7.23)	19.65 (5.85)	21.24 (5.38)	20.73 (5.27)	0.94 (.40)	1.89 (.18)	0.63 (.54)
CIQ	12.70 (12.70)	12.55 (5.38)	13.50 (5.12)	12.87 (5.67)	13.87 (4.53)	13.44 (5.04)	14.59 (5.32)	14.00 (5.15)	0.834 (.44)	0.189 (.67)	0.41 (.66)

Note. DANVA2-AF = Diagnostic Analysis of Nonverbal Accuracy2-Adult Faces; FAB-3 = Facial Affect Naming subtest of the Florida Affect Battery; EIST = Emotional Inference from Stories Test; IRI = Interpersonal Reactivity Index; LISERES-A = Life Stressors and Social Resources Inventory; BDI = Beck Depression Inventory; CIQ = Community Integration Questionnaire.

Table 8

Stories and Control Group Mean Scores on Outcome Measures and Repeated Measures ANOVA Results

	Stories				Control				Difference		
	Baseline Mean (SD)	Post-test Mean (SD)	3 month Mean (SD)	6 month Mean (SD)	Baseline Mean (SD)	Post-test Mean (SD)	3 month Mean (SD)	6 month Mean (SD)	Time F(p)	Group F (p)	Group × Time F(p)
Outcome for participants											
DANVA2-AF	13.98 (2.17)	16.45 (3.15)	15.49 (4.38)	15.95 (3.76)	13.17 (2.33)	14.54 (3.80)	14.75 (4.06)	14.09 (3.55)	1.91 (.13)	1.10 (.38)	1.81 (.30)
FAB-3	14 (2.73)	14.61 (3.40)	14.87 (3.35)	14.63 (4.15)	14.25 (2.08)	15.12 (3.05)	15.33 (2.62)	15.60 (2.46)	0.62 (.60)	0.52 (.51)	0.36 (.73)
EIST	7.91 (2.34)	9.01 (2.34)	9.28 (2.50)	8.81 (3.29)	7.77 (2.22)	8.88 (1.91)	8.28 (2.61)	7.41 (3.19)	**9.72 (.001)**	2.71 (.14)	1.70 (.23)
IRI	64.04 (13.05)	59.73 (15.72)	61.93 (13.29)	62.97 (15.70)	56.70 (12.98)	54.41 (16.21)	58.10 (16.72)	58.44 (18.43)	0.50 (.64)	1.12 (.38)	0.11 (.88)
LISRES-A (stress)	13.83 (5.08)	13.01 (4.91)	12.50 (4.42)	11.64 (4.30)	12.79 (4.71)	13.13 (4.81)	11.04 (4.21)	10.94 (3.98)	0.15 (.87)	0.04 (.87)	1.30 (.30)
LISRES-A (support)	23.57 (5.32)	24.11 (4.81)	23.56 (4.86)	23.97 (6.01)	24.00 (4.33)	22.75 (5.49)	22.80 (6.09)	23.20 (5.64)	0.83 (.49)	2.55 (.12)	0.22 (.80)
BDI	15.96 (9.96)		11.74 (9.27)		12.58 (10.49)		8.95 (8.33)			0.11 (.75)	
Outcome for informants											
IRI	46.76 (19.03)	52.42 (19.33)	42.85 (15.89)	44.07 (12)	43.48 (15.65)	41.39 (17.46)	43.12 (17.54)	41.67 (15.69)	1.71 (.19)	1.25 (.28)	0.55 (.58)
LISRES-A (stress)	13.96 (5.18)	13.44 (4.67)	13.92 (4.65)	14.94 (5.90)	16.00 (5.50)	13.76 (4.42)	11.65 (4.50)	13.33 (5.01)	1.39 (.26)	1.73 (.21)	0.35 (.70)
LISRES-A (support)	19.22 (5.62)	19.61 (7.20)	20.69 (7.90)	18.21 (6.69)	21.00 (7.23)	19.65 (5.85)	21.24 (5.38)	20.73 (5.27)	1.85 (.17)	0.02 (.88)	0.31 (.73)
CIQ	14.78 (4.47)	14.68 (4.49)	15.60 (5.73)	13.41 (5.21)	13.87 (4.53)	13.44 (5.04)	14.59 (5.32)	14.00 (5.15)	0.32 (.73)	0.05 (.82)	0.11 (.89)

Note. DANVA2-AF = Diagnostic Analysis of Nonverbal Accuracy2-Adult Faces; FAB-3 = Facial Affect Naming subtest of the Florida Affect Battery; EIST = Emotional Inference from Stories Test; IRI = Interpersonal Reactivity Index; LISERES-A = Life Stressors and Social Resources Inventory; BDI = Beck Depression Inventory; CIQ = Community Integration Questionnaire.

A similar repeated 2 × 3 (Group × Session) Repeated Measures ANCOVA analysis was conducted on the FAB-3 Facial Affect Naming total scores. There were no main effects of group, $F(1, 44) = .49$, $p = .52$, $\eta_p^2 = 0.001$, or time, $F(2, 88) = 0.56$, $p = .60$, $\eta_p^2 = 0.001$, over the three post-treatment data points (illustrated by Figure 8). Nor was there significant interaction effect between group and time, $F(2, 88) = 1.36$, $p = .47$, $\eta_p^2 = 0.002$. Figures 9 and 10 depict the findings related to changes in performance of the FAB-3 Facial Affect Naming of each treatment group across the six-month study.

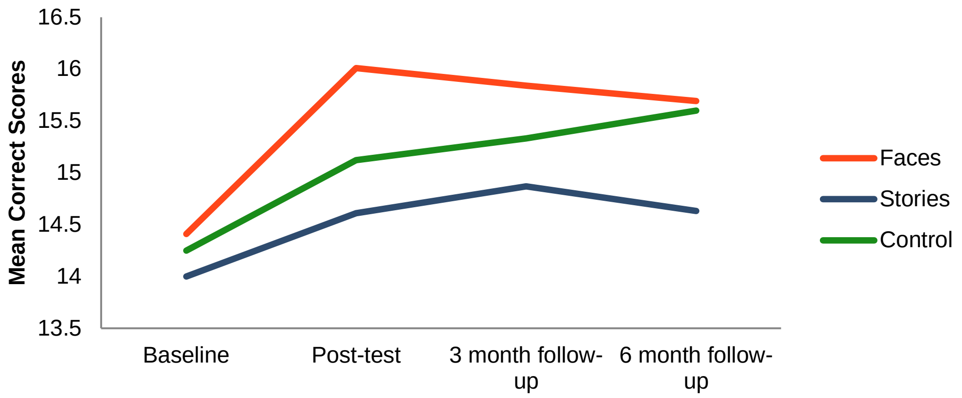


Figure 9. Estimated marginal mean scores at each time point for the Facial Affect Naming (subtest 3) of the Florida Affect Battery.

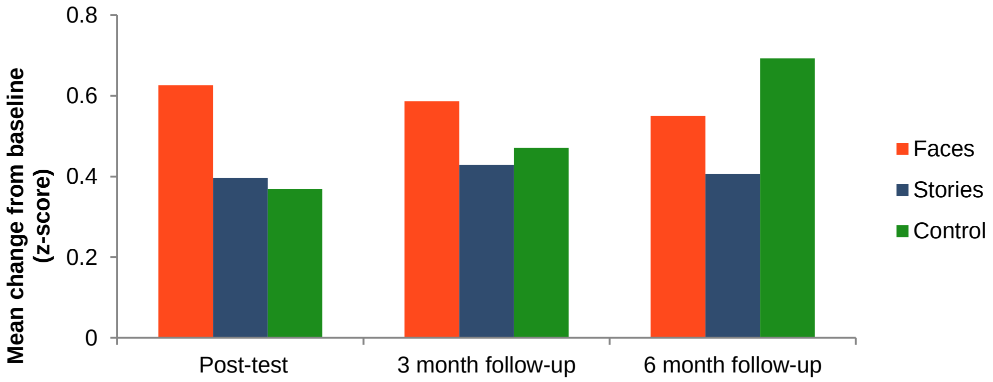


Figure 10. Mean change in FAB-3 Facial Affect Naming z-scores from baseline to post-test, from baseline to three months, and from baseline to six months for each treatment group. The FAB-3 Facial Affect Naming raw scores are converted to z-scores based on published normative data.

Stories versus control

The performance of the *Stories* group was also compared to the control group to examine the effects of intervention on the facial affect recognition measures. A 2 x 3 (Group x Session) Repeated Measures ANCOVA conducted on the DANVA2-Adult Faces total scores across the three post-treatment time points yielded no significant group by time interaction, $F(2, 78) = 1.81$, $p = .30$, $\eta_p^2 = 0.004$. No main group, $F(1, 44) = 1.10$, $p = .38$, $\eta_p^2 = 0.002$ or time effects, $F(2, 78) = 1.91$, $p = .13$, $\eta_p^2 = 0.041$ were observed (see Figures 7 and 8). All these findings suggest that there was no change over time for either group in facial affect recognition ability.

Analysis for the FAB-3 Facial Affect Naming total scores paralleled that conducted with the DANVA2-Adult Faces, with no significant main effect for group, $F(1, 44) = 0.52$, $p = .51$, $\eta_p^2 = 0.001$ or time, $F(2, 88) = 0.62$, $p = .60$, $\eta_p^2 = 0.01$ across the three post-treatment data points. There was no significant interaction between group and time on the FAB-3 Facial Affect Naming total scores**,** $F(2, 88) = 0.36$, $p = .73$, $\eta_p^2 = 0.008$ (see Figures 9 and 10)**.**

Emotional Inference from Context

The second set of analyses examined the effects of intervention on the levels of emotional inferencing ability.

Faces versus Control

To examine differences between the *Faces* and control groups in terms of their ability to infer emotions from context during the course of the intervention, another set of 2 x 3 (Group x Session) Repeated Measures ANCOVA analyses was conducted on the EIST total scores. As can be seen in Figure 11, no significant main effects could be detected of group, $F(1, 44) = 1.55$, $p = .23$, $\eta_p^2 = 0.034$, time, $F(2, 88) = 3.44$, $p = .09$, $\eta_p^2 = 0.07$, or group by time interaction effect, $F(2, 88) = 1.50$, $p = .36$, $\eta_p^2 = 0.003$ across the three post-treatment time points.

Stories versus Control

Using similar 2 x 3 (Group x Session) Repeated Measures ANCOVA analysis, the performance of the *Stories* group was compared with that of the control group to examine the effects of intervention on the ESIT measure. Again, there was no significant interaction effect between group and time, $F(1.81, 79.7) = 1.70$, $p = .23$, $\eta_p^2 = 0.004$, and no main effect of group, $F(1, 44) = 2.71$, $p = .14$, $\eta_p^2 = 0.04$ (see Figure 11). A significant effect of time across the three post-treatment points was observed, however, $F(1.81, 79.7) = 9.72$, $p = .001$, $\eta_p^2 = 0.18$. This indicates that irrespective of the group to which they belonged, the participants improved over time to a similar extent—this improvement may reflect a practice effect on the measure itself.

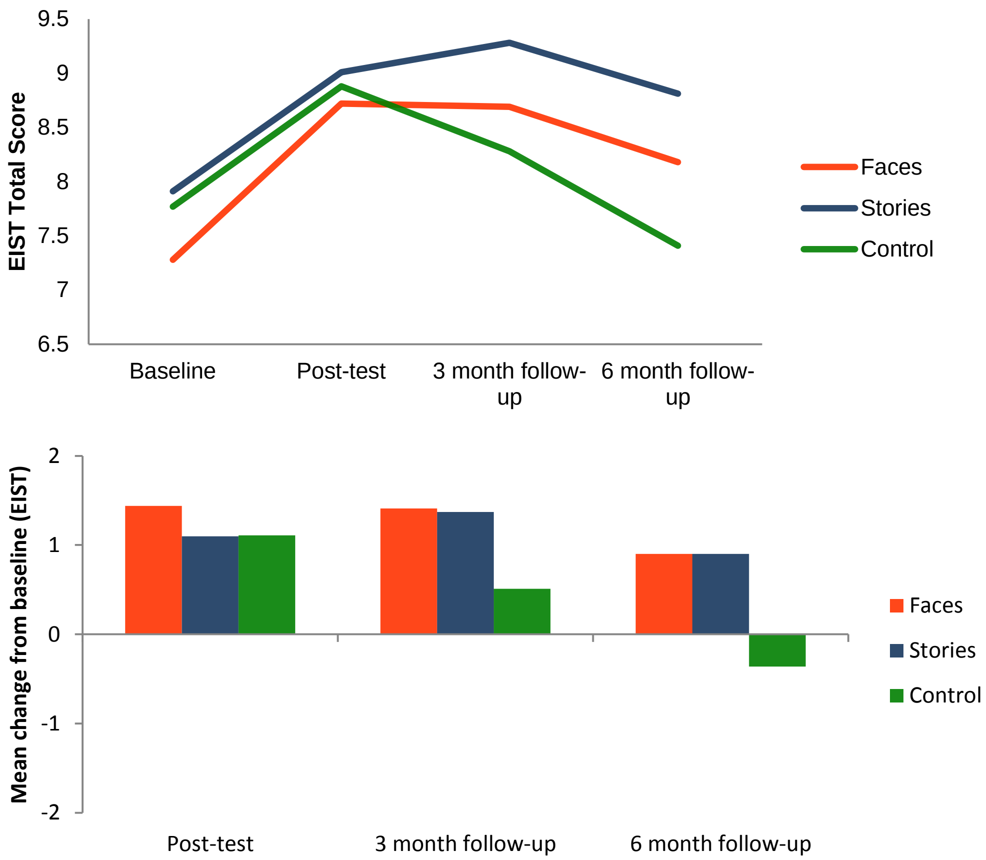


Figure 11. EIST total scores in each treatment group at baseline, post-treatment, three-and six-month follow-up of treatment and the change in EIST scores from baseline to each of the three time points. EIST = Emotional Inference from Stories Test.

Empathy

The third set of analyses assessed the impact on the participants of the training in empathy functioning.

Faces versus Control

IRI results for both participants and their informants are presented in Figure 12. To evaluate whether empathy functioning showed a greater improvement in the *Faces* group than in the control group, a 2 x 3 (Group x Session) Repeated Measures ANCOVA was carried out on the participants' total IRI scores. There were no main effects of group, $F(1, 44) = 0.04$, $p = .51$, $\eta_p^2 = 0.009$ or time, $F(1.70, 74.76) = 0.50$, $p = .61$, $\eta_p^2 = 0.01$. Nor were there significant time by group interactions, $F(1.70, 74.76) = 0.35$, $p = .68$, $\eta_p^2 = 0.007$. Given that Decety (2011) and Diziobek et al. (2007) suggest that out of the four subtests of the IRI, empathic concern and personal distress are the two subtests that are most related to emotion recognition, a similar repeated 2 × 3

(Group × Session) Repeated Measures ANCOVA analysis was conducted separately on each of the four IRI subscales (perspective taking, fantasy, empathic concern and personal distress. No significant main effects could be detected of group, time, or group by time interaction effect across the three post-treatment time points (all *ps* > .05). Analysis of the informants' total IRI scores indicated a trend towards a significant effect of group, $F(1, 26) = 3.40$, $p = .07$, $\eta_p^2 = 0.12$. Further exploration of this showed that while informants for the *Faces* group endorsed improved expression of empathy over time on the part of the participants (M = 49.31 to 51.56, SD = 15.93 to 18.06), this was not the case for the informants for the control group (M = 37.62 to 41.31, SD = 16.41 to 16.85) over time. A non-significant effect of time, $F(1.57, 40.81) = 0.70$, $p = .70$, $\eta_p^{2\,=}$ 0.03 and of interaction between group and time effect ,$F(1.57, 40.81) = 0.26$, $p = .77$, $\eta_p^{2\,=}$ 0.010 was observed. Similarly, analysis of the four subtests of IRI yielded no significant main effects of group, time, or group by time interaction effect across the three post-treatment time points (all *ps* > .05).

Stories versus Control

A similar 2 x 3 (Group x Session) Repeated Measure ANCOVA was conducted comparing the *Stories* and control groups' performance on the participants' total IRI scores As shown in Figure 12, no significant main group effect, $F(1, 44) = 1.12$, $p = .38$, $\eta_p^2 = 0.025$ or time effect, $F(1.79, 78.7) = 0.50$, $p = .64$, $\eta_p^2 = 0.01$, or group interaction with time, $F(1.79, 78.7) = .11$, $p = .88$, $\eta_p^2 = 0.002$ was observed. Likewise, analysis of the four subtests of IRI showed no significant main effects of group by time, group or time across the three post-treatment time points (all *ps* > .05).

Similarly, analysis of the informants' total IRI scores paralleled that conducted for the IRI scores of the participants, with no significant main effects for group, $F(1, 20) = 1.25$, $p = .28$, $\eta_p^2 = 0.059$, time, $F(2, 40) = 1.71$, $p = .19$, $\eta_p^2 = 0.079$ or group by time interactions, $F(2,40) = 0.548$, $p = .58$, $\eta_p^2 = 0.027$. Taken together, these findings suggest that the treatment groups did not improve in empathy skills during the course of the study, although informants for participants in the Faces group reported a non-significant tendency for increased empathy over time. Analysis of the four subtests of IRI also yielded no significant main effects of group, time, or group by time interaction effect across the three post-treatment time points (all *ps* > .05).

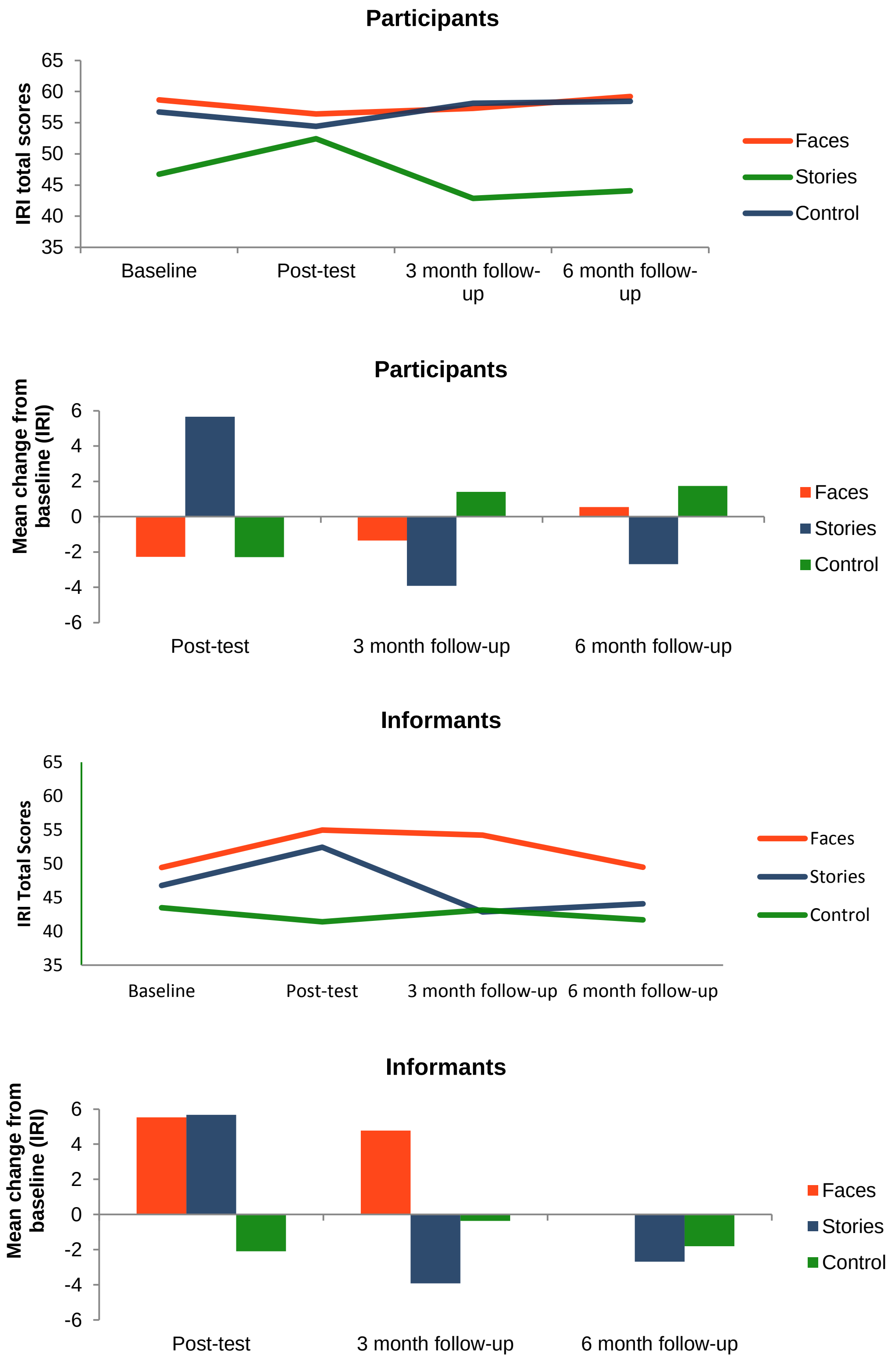


Figure 12. IRI total scores for participants and their informants in each treatment group at baseline, post-treatment, three-and six-month follow-up and the change in IRI scores from baseline to each of the three time points by treatment condition. IRI = Interpersonal Reactivity Index.

Social Functioning

The fourth set of analyses investigated whether the positive impact of the treatment would transfer to the participants' interpersonal and social functioning or be limited to affect recognition competence. Figures 13, 14, and 15 show how scores on these interpersonal and social functioning measures changed over time for participants and informants respectively in each treatment group.

Faces versus Control

A series of 2 x 3 (Group x Session) Repeated Measures ANCOVAs was conducted to compare *Faces* and control group changes in performance on the two subscales of LIRSES-A and CIQ total scores at the three post-treatment time points (post-test, three-month follow-up, six-month follow-up).

In the total scores for the participants' LIRSES-A Interpersonal Stressor subscale, the 2 x 3 (Group x Session) Repeated Measures ANCOVA indicated no significant group by time interaction effect, $F(2, 88) = 2.68$, $p = .15$, $\eta_p^2 = 0.005$ (see Figure 13). There was a trend towards a main effect for group, $F(1, 44) = 4.65$, $p = .06$, with participants in the *Faces* group reporting that they experienced more distress, $M = 14$ to 14.9, $SD = 4.42$ to 5.33, than those in the control group, $M = 10.93$ to 13.1, $SD = 4.01$ to 4.81, after the treatment. No significant main effects of time were observed across three post-treatment data points, $F(2, 88) = 0.27$, $p = .80$, $\eta_p^2 = 0.001$.

There was no evidence of significant main group effects, $F(1, 24) = 0.84$, $p = .37$, $\eta_p^2 = 0.03$, time effects, $F(2, 48) = 1.04$, $p = .36$, $\eta_p^{2\,=}$ 0.04, or of differences between group and time effects, $F(2, 48) = 2.36$, $p = .11$, $\eta_p^{2\,=}$ 0.09, when the same analyses of this measure were repeated for the informants (see Figure 13).

In the participants' total scores for the LIRSES-A Interpersonal Resource subscale, there was no main effect for group, $F(1, 44) = 0.15$, $p = .75$, $\eta_p^2 = 0.004$, time, $F(2, 88) = .45$, $p = .72$, $\eta_p^2 = 0.001$ and no interaction between time and group, $F(2, 88) = 0.56$, $p = .52$, $\eta_p^2 = 0.05$ (see Figure 13). Similar analysis of the informants' total scores for the LIRSES-A Interpersonal Resource subscale revealed no significant main effects of group, $F(1,24) = 1.89$, $p = .18$, $\eta_p^2 = 0.073$, or time, $F(2, 48) = 0.94$, $p = .40$, $\eta_p^2 = 0.038$, nor was there a significant interaction observed between time and group, $F(2, 48) = 0.63$, $p = .54$, $\eta_p^2 = 0.026$ (see Figure 14).

In the informants' total CIQ scores, as shown in Figure 15 the 2 x 3 (Group x Session) Repeated Measure ANCOVA revealed no significant group by time interaction, $F(2, 50) = 0.41$, $p = .66$, $\eta_p^2 = 0.016$. No main group, $F(1, 25) = 0.19$, $p =.67$, $\eta_p^2 = 0.007$ or time effects, $F(2, 50) = 0.82$, $p =.44$, $\eta_p^2 = 0.032$ were observed.

Stories versus Control

The above analyses were repeated to compare the performance of the *Stories* group with the control group to examine the influence of the intervention on the interpersonal and social functioning measures.

For participants' total scores in the LIRSES-A Interpersonal Stressor subscale, no main effects of group could be detected, $F(1, 44) = .04$, $p = .87$, $\eta_p^2 = 0.001$. No significant main time effects, $F(1.70, 74.76) = 0.15$, $p =.87$, $\eta_p^2 = 0.003$ or time by group interactions, $F(1.70, 74.76) = 1.30$, $p =.30$, $\eta_p^2 = 0.003$ were observed either (Figures 12). Similarly, the 2 x 3 (Group x Session) Repeated Measures ANCOVA of informants' total scores for the LIRSES-A Interpersonal Stressor subscale yielded no significant main effects of group, $F(1, 18) = 1.73$, $p = .21$, $\eta_p^2 = 0.088$, time effects, $F(2, 36) = 1.39$, $p =.26$, $\eta_p^{2 =}$ 0.072 or group and time interaction effects, $F(2, 36) = 0.35$, $p = .70$, $\eta_p^2 = 0.019$ (see Figures 13).

For the participants' total scores in the LIRSES-A Interpersonal Resource subscale, the 2 x 3 (Group x Session) Repeated Measures ANCOVA indicated no main effect for group, $F(2, 88) = 2.55$, $p = .12$, $\eta_p^2 = 0.05$, time, $F(2, 88) = 0.83$, $p = .49$, $\eta_p^2 = 0.002$ and for interactions between time and group, $F(2, 88) = 0.22$, $p = .80$, $\eta_p^2 = 0.005$ (see Figure 13). Again, there were no significant main effects of group, $F(1,18) = .023$, $p = .88$, $\eta_p^2 = 0.001$ or time, $F(2, 36) = 1.85$, p = .17, $\eta_p^2 = 0.093$, nor was significant interaction between time and group, $F(2, 36) = 0.31$, $p = .73$, $\eta_p^2 = 0.017$ observed in informants' LIRSES-A Interpersonal Resource subscale total scores (see Figure 14).

.

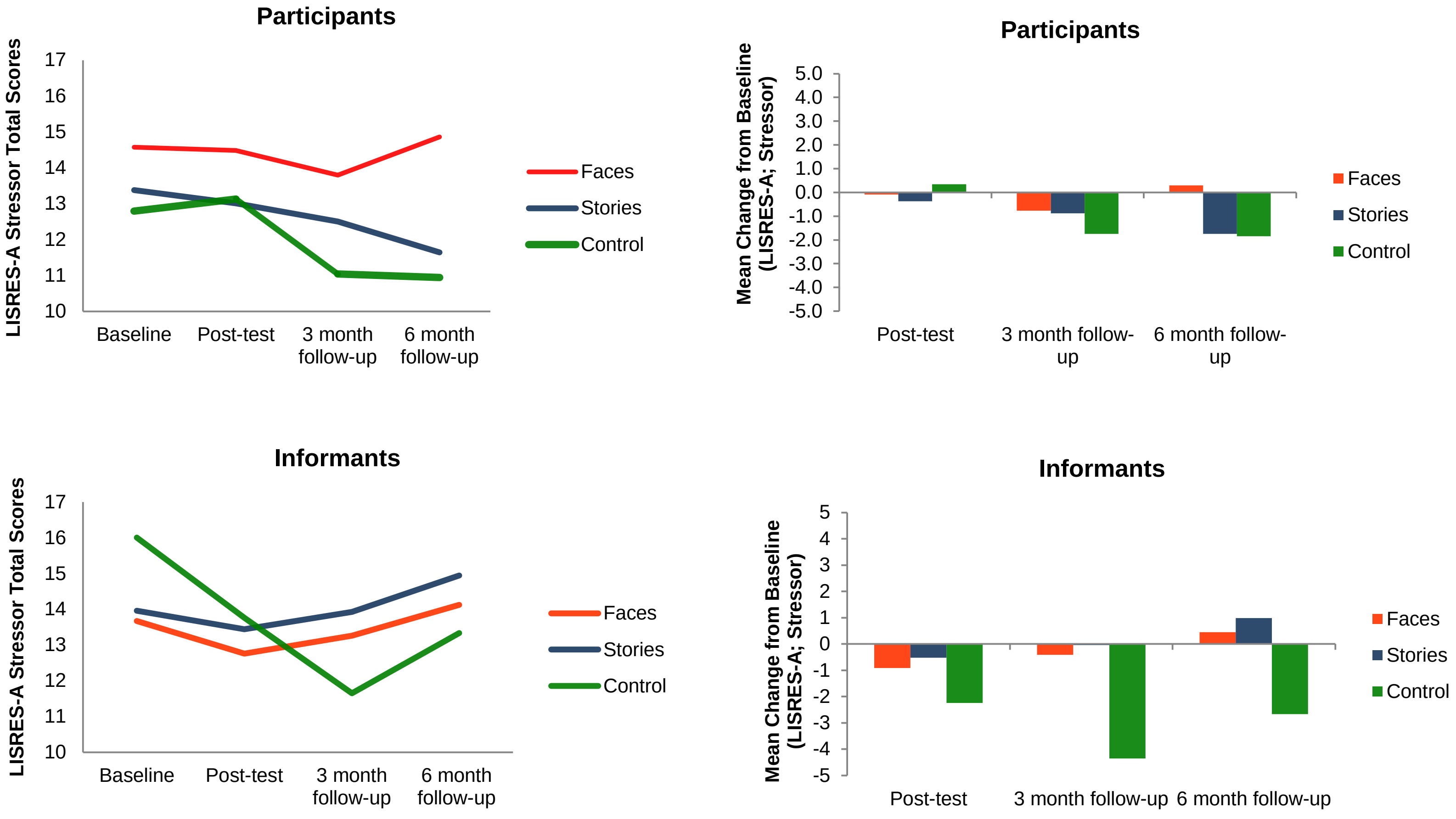


Figure 13. Estimated marginal mean scores at each time point for the LISRES-A Stressor of the three treatment groups and the change of baseline for these measures at post-test, three and six months after treatment for participants and informants. LISRES-A Stressor Subscale = the Interpersonal subscale of the Life Stressors and Social Resource Inventory-Adult Form.

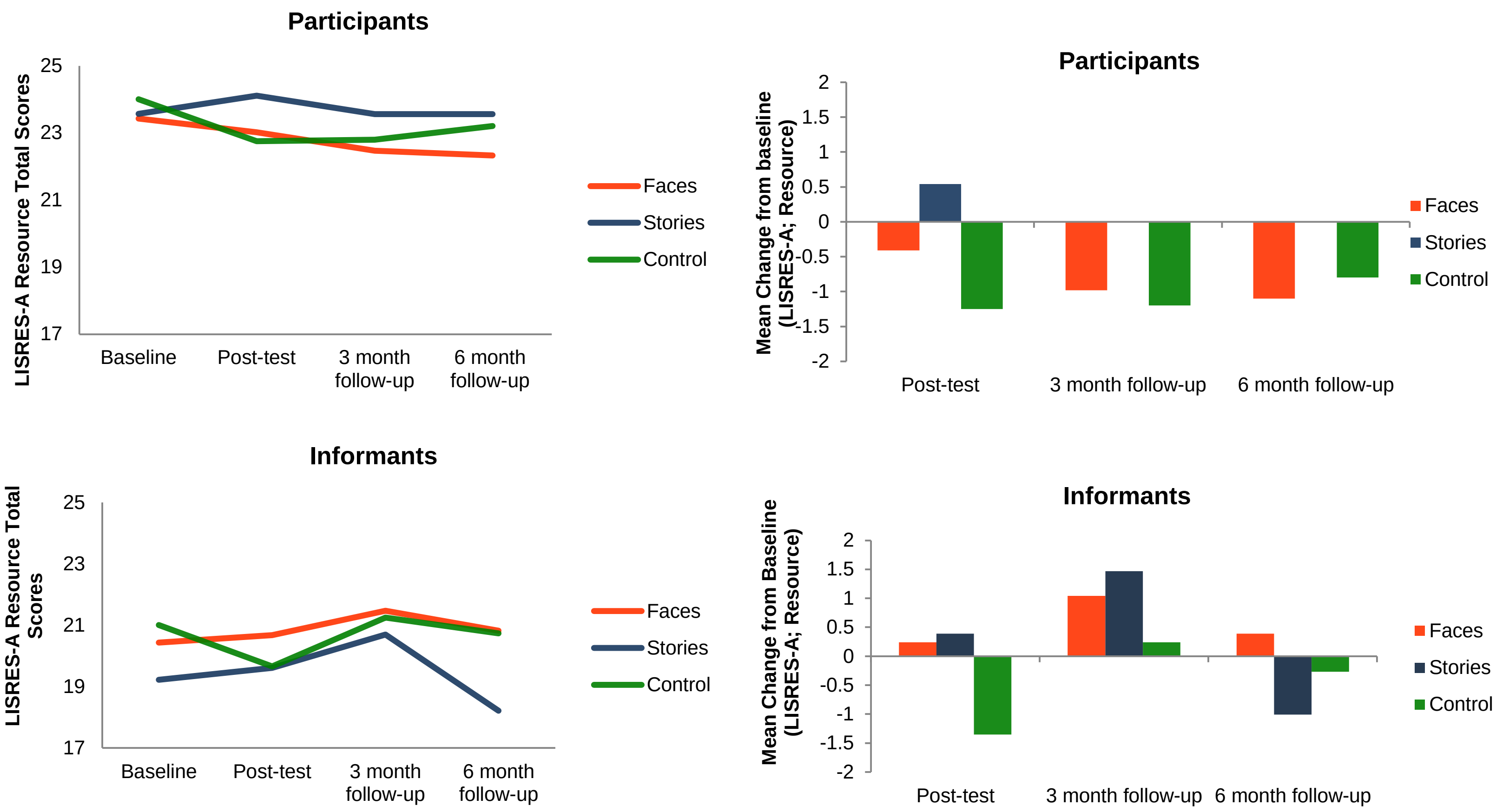


Figure 14. Estimated marginal mean scores at each time point for the LISRES-A Support of the three treatment groups and the change of baseline for these measures at post-test, three and six months after treatment for participants and informants. LISRES-A Stressor Subscale = the Interpersonal subscale of the Social Resource Inventory-Adult Form.

For informants' reported CIQ total scores (Figure 15), the main effects of group and time interaction were non-significant, $F(2, 38) = .11$, $p = .89$, $\eta_p^2 = 0.006$; nor was there any statistical significance in the main effects of group, $F(1,19) = .05$, $p = .82$, $\eta_p^2 = 0.003$ and time, $F(2, 38) = 0.32$, $p = .73$, $\eta_p^2 = 0.016$. Taken together, on the measures of participants' interpersonal and social competence administered in this research, therefore, informants reported no significant improvement in interpersonal and social functioning.

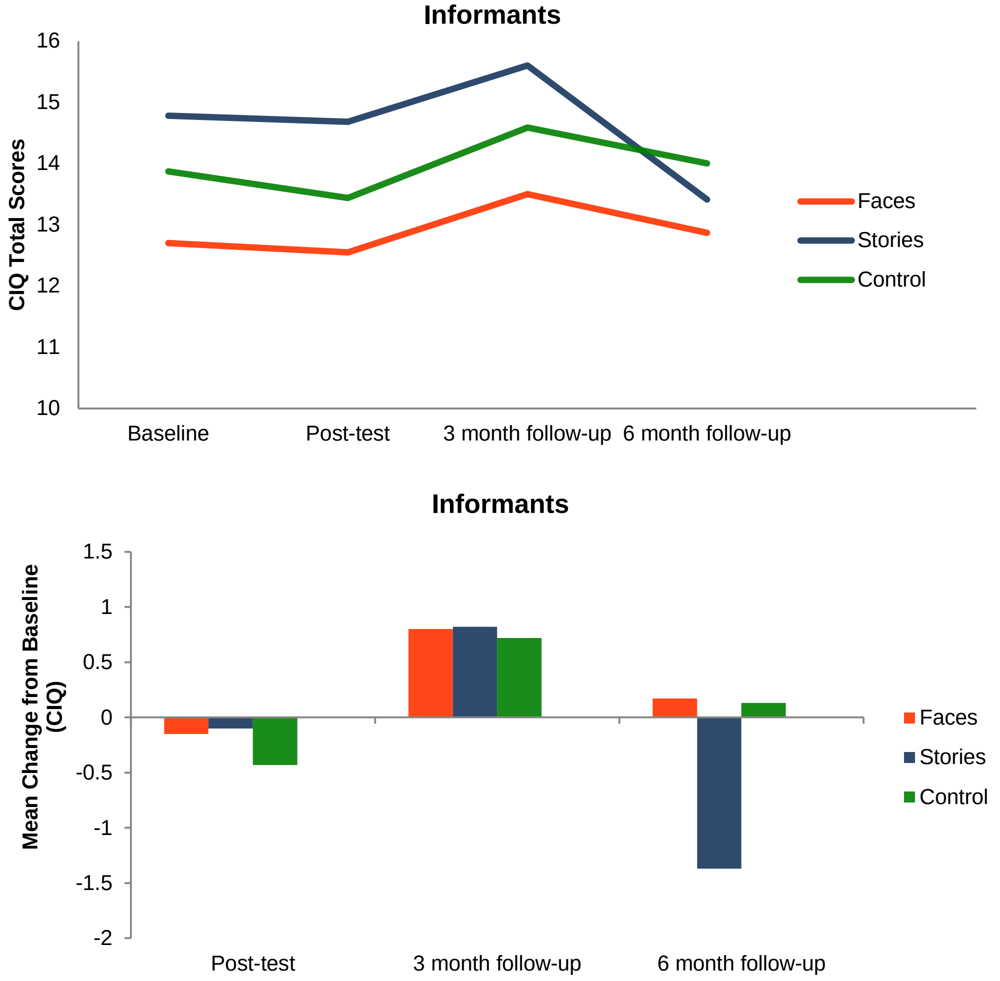


Figure 15. Estimated marginal mean scores at each time point for the CIQ of the three treatment groups and the change of baseline for these measures at post-test, three and six months after treatment for participants and informants. CIQ = Community Integration Questionnaire.

Depression

The final analyses examined the extent to which improvement in affect recognition would reduce participants' levels of depression.

Faces versus Control

A one-way ANCOVA, controlling for pre-treatment scores, was conducted on the three-month follow-up BDI scores between the *Faces* and the control groups to evaluate whether the intervention had an impact on depression. As shown in Figure 16, there were no significant differences between the two groups of participants, $F(1, 36) = 2.95$, $p = .10$.

Stories versus Control

When the same analysis was used to compare the *Stories* group with the control group in order to evaluate the effects of the intervention on depression, also no differences could be detected between the two groups, $F(1, 36) = 0.11$, $p = .75$ (see Figure 16). All these findings suggest that there is no reduction in the participants' level of depression after intervention.

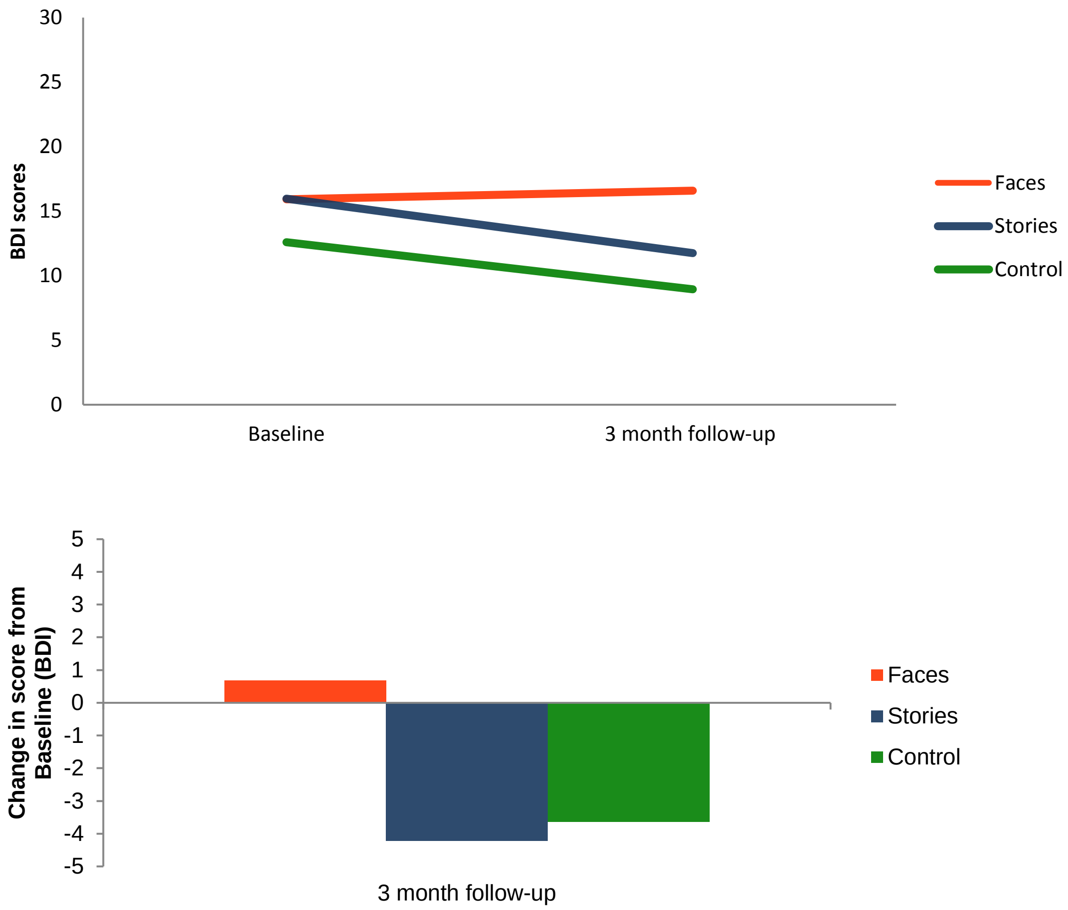


Figure 16. Changes in BDI total scores for each training group and mean changes in BDI total scores from baseline to 3 month follow-up. BDI = Beck Depression Inventory.

Chapter 8: Study One Discussion

This study examined the efficacy of two training programmes designed to enhance affect recognition in people with brain injury who had been identified with this impairment. It is one of the three randomised controlled trials to both assess the effects of affect recognition intervention beyond three months, and to explore any positive effects of the affect recognition intervention on interpersonal and social functioning. Previous research has suggested that people with brain injury can regain affect recognition skills through training (Bornhofen & McDonald, 2008b, 2008c; Guercio et al., 2004; Radice-Neumann et al., 2009). As predicted, this study found that when the DANVA2-Adult Faces measure was administered at the end of the training, participants who had received the *Faces* intervention significantly improved their ability to recognize emotion from faces when compared to the control condition whereas the *Stories* intervention did not. This positive effect was maintained at the three and six month follow-up, suggesting durability in the Faces treatment. The effect size of the improvement was large (partial eta squared = 0.37 to 0.53) after this intervention. The data support the first hypothesis and confirm the findings of the pilot study (Radice-Neumann et al., 2009) that demonstrated improved facial affect recognition following *Faces* intervention in adults with TBI.

The improvement in the DANVA2-Adult Faces scores for participants who had received the *Faces* intervention and not the *Stories* intervention is evidence that directing visual attention to key features of faces expressing emotion may be one critical tool in facilitating facial affect recognition skills in people with TBI. This proposition is consistent with mounting evidence from healthy and clinical populations suggesting a link between patterns of visual scanning of facial features and performance in facial affect recognition tasks (Adolphs et al., 2005; Combs et al., 2008; Eisenbarth & Alpers, 2011; Schwaninger et al., 2006; Vassallo et al., 2011). It remains to be determined whether, in TBI, improvement in facial affect recognition after *Faces* training is accompanied by changes in visual scanning of faces. Use of sophisticated technology such as eye tracking devices to assess visual scan paths would possibly cast light on this area.

More intriguing perhaps was the finding that the treatment gains achieved in the *Faces* group were sustained after six months. It is likely that participants might have transported and applied the strategies taught from the treatment sessions to their day-to-day lives, resulting in better understanding of other people's feelings. This may in turn have led to changes in their behaviour that were reciprocated and then reinforced, thereby maintaining the treatment effects.

In addition, it is hypothesized that the combined effects in the *Faces* intervention of perception shaping (visual attention) and internal emotional simulation may amplify the activity of neural regions involved in facial expression processing, and engender deep changes within the affect recognition system over time. This interpretation accords with the current theories of facial affect recognition documenting the intimate association of both the perceptual and simulation processes in processing others' facial expressions (Adolphs, 2002; Halberstadt et al., 2011). It is acknowledged however that factors such as participants' motivation may also play a role in therapeutic improvement. Motivation has been increasingly recognised as an important predictor of treatment outcome for a range of clinical disorders including TBI (Medalia & Saperstein, 2011; Prigatano, 2005). More research is needed to elucidate the precise mechanisms underpinning the efficacy of the *Faces* intervention. Given what has been learnt about neuroplasticity in recent years (Gllick & Zirpel, 2012; Lillard & Erisir, 2011), one priority for outcome studies will be to investigate through use of imaging techniques whether affect recognition training can affect brain function, and if so, which components of the training promote the level of brain plasticity necessary for emotion recognition accuracy? Such knowledge may help to maximize the techniques for mitigating affect recognition deficits in people with brain injury.

For the second measure of facial affect recognition—FAB-3 Facial Affect Naming — different results were obtained: there were no changes after the training in either of the two treatment groups when compared to the control group. The reason for the difference is unclear, but one possible explanation is that the FAB-3 Facial Affect Naming may not have been sensitive enough to detect facial affect recognition changes in the TBI population. While a literature search revealed that the DANVA2-Adult Faces has been successfully used as a treatment outcome measure to assess changes in facial affect recognition in people with TBI (Radice-Neumann et al., 2009), there is, to my knowledge, no such published information for the FAB-3 Facial Affect Naming. The latter may not then be an ideal treatment outcome measure for persons with brain injury. These findings underscore the need for further validation of the psychometric properties of the existing facial affect recognition measures. (An initial work has in fact recently begun to address this area within the context of a wider study, D R Babbage, Zupan, Neumann, & Willer, 2012, July) There is also a clear need to establish the measures' clinical utility for people with TBI in terms of sensitivity to change in facial affect recognition.

The second hypothesis predicted that the *Stories* treatment group would score significantly higher than the control group on measures of emotional inferencing. This was not supported. Neither the *Stories* nor *Faces* participants had increased scores on the EIST. These findings partly replicated those of Radice-Neumann et al. (2009), who found that following training participants in the *Stories* group failed to demonstrate significant improvements in their ability to infer the emotions of others from context. This result was nonetheless unexpected, given that the *Stories* intervention specifically taught participants to infer others' emotions from contextual information provided. As has been suggested by Radice-Neumann et al. (2009), this finding might be reflective of self-centredness, a trait often ascribed to individuals with TBI (Santoro & Spiers, 1994).

Another possible explanation for the lack of effects relates to the nature of the intervention. In the *Stories* intervention participants were actively encouraged to reason about/infer affective states, including the desires and behaviours of story characters in different social contexts (e.g., what a character thinks about another person's feelings). It is likely that such processing places a relatively heavy demand on cognitive resources and even implicitly draws on social cognitive rather than social perceptual aspects of theory of mind per se. The social cognitive aspect of theory of mind is believed to be associated with higher cognitive functions such as executive functioning and language (de Villiers, 2007; Dennis, Agostino, Roncadin, & Levin, 2009; Fisher, Happe, & Dunn, 2005). Given that moderate to severe TBI has been shown to result in neuropsychological dysfunction in many cognitive domains including theory of mind (Bibby & McDonald, 2005; Channon et al., 2005; Dikmen et al., 2009; Draper & Ponsford, 2008; Muller et al., 2010; Niemeier, Marwitz, Lesher, Walker, & Bushnik, 2007), it is reasonable to assume that participants' ability to fully benefit from the *Stories* training may have been compromised, particularly in the case of those with a lower level of cognitive functioning. At the New Zealand site during the *Stories* intervention sessions, I noted that some participants experienced difficulty in following the stories through, and others took a longer time to respond and some responded, “I would not feel that way, I would feel like this”. The validity and reliability of the EIST in assessing emotional inference ability also needs, however, to be considered.[13] It is possible, for example, that a ceiling effect precluded a differential effect of training from being seen on this measure, and that therefore the test was not sufficiently sensitive to detect improved emotional inference performance in the *Stories* group.

The above interpretation suggests that further modification and improvement of the *Stories* training programme may be required. For the emotional inference stories, it would perhaps be useful to include relevant pictures in addition to the written text, as greater visual explicitness could potentially reduce the cognitive loading on the participants. This might in turn help them to better integrate the contextual information, and might facilitate, conceivably, affective inference processing. Alternatively, use of video vignettes depicting the interactions of the characters in the stories in different social situations may better induce changes in affective inference processing, as such vignettes tend to resemble real-life situations and would provide additional ecological validity. The advantages of video in facilitating the process of emotional and social attunement in people with schizophrenia and autism have been described elsewhere (Bazin et al., 2009; Bechi et al., in press). Another possibility is that a lengthier period of *Stories* training is needed before any measurable change in emotional inferencing can be seen. More studies are needed to clarify this area. As EIST is a newly developed measure, further psychometric testing of the measure is clearly warranted.

Little support was found either for the third hypothesis, which posited that after training, participants who received either the *Faces* or the *Stories* intervention would exhibit greater empathy than those in the control group. No significant between-group difference in the participants’ IRI scores was finally observed. On the informants’ IRI scores, however, it was noted that there was a trend which showed the *Faces* group improving on empathy to a greater extent than the control group across the three post-treatment time points. As the sample was relatively small, this may be due to the lack of power, as a medium effect seems to be present: Means (with standard deviations) for *Face*s group and control group informants were 50.42 (17.01) and 39.90 (16.56)

[13] As stated in Chapter 6, the EIST was specifically developed by the wider study as there are currently very few instruments available designed to assess emotional inference abilities in people with brain injury.

respectively. It is likely therefore that empathic responses would have been significantly improved following the *Faces* training had the informants' sample size been larger. The different findings for participants' empathy skills according to their own self-report versus the information provided by their informants are not surprising. Firstly, a significant number of people with TBI have been shown to display limited self-awareness (Flashman & McAllister, 2002; Sherer et al., 1998b). Secondly, individuals with TBI displaying poor self-awareness have been found to demonstrate reduced empathy skills (Burridge, Williams, Yates, Harris, & Ward, 2007). Reduced insight into their own emotional skills may therefore partly account for the above discrepancy. Collection of multiple collateral information from significant others is important to increase data reliability, as self-report measures by individuals with TBI could be influenced by a number of variables. A measure assessing patients' level of insight such as the Patient Competency Rating Scale is recommended (Leathem, Murphy, & Flett, 1998; Sherer, Hart, & Nick, 2003a).

With regard to the trend in increased empathy reported by informants and found over time in the *Faces* group, it is hypothesized that unlike *Stories* training, *Faces* training may have specifically addressed a key aspect of empathy. As this intervention involves the practice of facial mimicking and inference-taking (e.g. asking participants to recall emotions associated with events in their own inference and mimicking the facial affect corresponding to that emotion), the simulation mechanism underpinning the emotional aspect of empathy capacity has in all probability been targeted. The facet of the training just outlined may have increased *Faces* group participants' awareness of other people's feelings, and this may in turn have enhanced their empathic feeling for those they care about. Evidence from the neuroimaging and behavioural studies has provided support for the conjecture that empathy, including facial affect recognition, relies partly on the process of internally simulating the same emotional state in oneself (Decety, 2011; Goldman & Sripada, 2005; Oberman, Winkielman, Vilayanur, & Ramachandran, 2007; Pineda & Hecht, 2009). The recent neurological evidence regarding "mirror neurons" (which map the correspondences between self and others) is thought to provide the neural basis for the simulation process (Dapretto et al., 2005; Decety, 2011). It would be interesting to explore whether participants use simulation when engaging in empathic processing as well as whether or not a dysfunctional mirror neuron system underlies the empathy deficits (including affect recognition impairments) following TBI. The extent to which this system can be modified by affect recognition training would be a further fascinating area for future investigation.

According to the fourth hypothesis, the *Faces* and the *Stories* groups should score higher on outcome measures relating to interpersonal and social functioning. Contrary to the prediction neither treatment group made significant improvements on the Interpersonal Resource subscale of LISRES-A (as reported by participants and their informants), nor on the CIQ, during the course of the study. On the Interpersonal Stressor subscale of LISRES-A, however, the *Faces* group participants demonstrated an almost significantly higher level of interpersonal distress than the control group after completion of training. The lack of observed changes in the interpersonal and social functioning measures are somewhat surprising, given that previous research has suggested a link between facial affect recognition and social behaviour in people with TBI (Knox & Douglas, 2009; Milders et al., 2003; Pettersen, 1991; Shorland & Douglas, 2010; Watts & Douglas, 2006). Although these findings should be interpreted with caution given the high rate of missing data from informants, a number of explanations are possible. The transfer of newly acquired affect recognition skills into social behavioural skills and daily social life may emerge only after a longer period of practice and time than is incorporated in the current study's monitoring. A follow-up evaluation one year after the treatment would test this hypothesis. It is also possible that the participants included in this study had inadequate social opportunities to practise (and demonstrate) affect recognition skills, and that their social functioning capacities were curtailed as a result. As the outcome measures assessing interpersonal and social functioning relied on participants' self-reports and on the reports of their informants, it is likely that the responses in both cases were influenced by expectations, or by unexpected negative life events that might have occurred over the six-month period of participation; and that these factors too had some bearing on results. Another possibility is that affect recognition, however necessary, is in itself insufficient to enhance real-life social outcomes in people with TBI. In line with this suggestion, Beauchamp and Anderson (2010) presented evidence that impaired social functioning experienced by patients with brain injury is a result of both external and internal factors (affect recognition is one such factor). In short, there is an apparent need for continued efforts to understand the nature of social difficulties in TBI and the ways the different factors interrelate. Such knowledge would assist in refining the affect recognition training programmes so that they produce gains in social outcomes.

An increase in self-awareness might be reflected in the tendency in the *Faces* group towards higher levels of interpersonal distress than the control participants. It is possible that as participants became more skilled at recognizing and understanding their own and other people's emotions after completion of the *Faces* training, they initially felt overwhelmed when encountering stressful social situations (e.g., observing and understanding that a loved one was feeling sad over a loss of a childhood friend). These negative emotional experiences may be intensified for those who lack appropriate strategies to cope with negative feelings or who are struggling to find the correct ways to respond to their loved one's sadness. This sense of inadequacy may leave them feeling frustrated and angry, thereby exacerbating their level of distress. It is hypothesized, however, that as the social adeptness of participants increases because of their greater understanding of their own emotions and those of others, the emotional distress will dissipate. Matching this assumption, several rehabilitation studies in TBI have reported an association between emotional distress and insight (Flashman & McAllister, 2002; Ownsworth & Fleming, 2005); and further, that an increase in clinical insight is an important factor in adaptive treatment outcome (Fleming & Ownsworth, 2006). It seems therefore that *Faces* training may have the potential to improve affect processing in adults with TBI and that an increase in self-awareness may be part of its contributory mechanism. More research is needed to clarify this area.

The final finding of the present study was that no improvements in depressive symptoms were found at the three-month follow-up for the *Faces* or the *Stories* group. This failed to support the fourth hypothesis: that as participants became less socially isolated due to improved social skills following treatment, their depressive symptoms would gradually attenuate. This finding is not consistent with other studies showing that facial affect recognition intervention leads to reduced depression (Penton-Voak, Bate, Lewis, & Munafò, 2012). Several explanations could account for this discrepancy. Firstly, these studies tended to have populations that were either clinically different from the current sample, or were a healthy population. TBI participants in the current study had a wider range of depressive symptoms, cognitive difficulties of a more severe nature, or poorer social support. Secondly, this lack of effect indicates that facial affect recognition impairments and depression in TBI may not be closely related and may have a different profile compared to other clinical populations. Martins and colleagues (2012), for instance, found that the performance by patients with TBI of emotion recognition tasks bore no relation to their scores for depressive symptoms. Additional work is required, therefore, to clarify the relationship between these two variables and ascertain how each contributes to social difficulties associated with people with TBI.

Taken together, findings from the current study have important clinical and theoretical implications. Firstly, given the high prevalence of facial affect recognition deficits in people with TBI, and the potential associated social difficulties, it is recommended that clinical assessments include measures evaluating facial affect recognition abilities alongside neuropsychological measures. Secondly, this research has shown that facial affect recognition impairments following brain injury can be regained through targeted computer-based remediation intervention. In particular, the findings suggest that *Faces* treatment is a potential rehabilitative tool for people with TBI in augmentation of affect recognition skills—this treatment can be easily incorporated into the clinical setting, as it is brief and structured. Thirdly, clinicians or other professionals providing this treatment should be mindful that individuals with TBI may experience overwhelming emotions during the therapy process, or face subsequent emotional difficulties of a kind previously unknown to them; and that they may lack the skills to cope in the social situations where such emotions occur. Provision of strategies, therefore, to help these individuals cope effectively with their negative emotional experiences is recommended to facilitate better adjustment in this domain, and would appear indeed to be a crucial further step in affect recognition training. Fourthly, involvement of families or significant others in treatment may be a critical factor in facilitating its efficacy, as these participants could help patients with TBI to transfer and apply the skills they have acquired. Family members could, for example, explicitly label their own emotions more often and the reasons they feel as they do, and prompt patients to do the same. At a wider social level, attention needs to be paid to increase the variety of social opportunities for people with brain injury to interact with others.

Finally, in terms of theoretical implication, the improvement resulting from the *Faces* treatment provides at least support for the perception and simulation theoretical models of emotion recognition (Adolphs, 2002; Eisenbarth & Alpers, 2011; Goldman & Sripada, 2005; Haxby et al., 2000; Sullivan et al., 2007). Specifically, the findings suggest that people with TBI who have shown deficits in emotion perception benefit from having their attention directed towards the relevant features of a facial expression and towards their own emotional experiences. With regard to the mechanisms underlying these effects, it would seem that a deliberate focus on both these locations might heighten the activation in the semantic system that would allow the conceptual information and the experiential response to a given emotion to come online more efficiently. The integration of this phenomenal internal experience along with external facial affect cues (visual, for example) would then lead to the facilitation of emotion recognition accuracy. This suggestion raises the question of whether some aspects of the affect recognition impairments following TBI may be due to reduced capacity to integrate both internal experiences and external emotional cues. Given previous theoretical findings which implicate the insula region in the relay and integration of information across the neural systems underpinning the cognitive, sensory and emotional processes (Carr, Iacoboni, Dubeau, Mazziotta, & Lenzi, 2003; Kurth, Zilles, Fox, Laird, & Eickhoff, 2010; Simmons et al., in press), and given also that the insula is one of the brain regions vulnerable to damage in TBI (Fontaine, Azouvi, Remy, Bussel, & Samson, 1999), this is indeed a possibility. This is a significant area for future research—one which may be a potential target for remediation aiming to increase affect recognition ability.

Several limitations in the present study should be noted. Firstly, the sample size is relatively small because 25% of the participants dropped out during the follow-up periods. This will have limited the ability to detect small changes. Additional studies with larger sample sizes would be useful to verify the strength of the patterns observed in this study. Secondly, the dropout rate for informants was high. Over 40% did not participate in the final follow-up assessment, which may well limit the generalizability of the informant results. From the informants' point of view, the questionnaires administered might have seemed lengthy and time-consuming; this leading in turn to a high informant dropout rate which may reduce the reliability of the results. In future investigations, improvement of follow-up rates would possibly involve more thorough screening of informants' background and the nature of their relationship with TBI patients. In addition, they could be provided with psycho-education about the negative effects of brain injury on affect recognition.

Another limitation of this study is that we used the published normative age-matched data for the calculation of DANVA2-Adult Faces z- scores. As mentioned earlier, the presentation time for the face stimuli in our study was increased from the standard 2 seconds to 15 seconds in order to minimise the influence of slowness in processing information and reduced visuo-perceptual capacities as a result of brain injury. While giving participants with TBI extra time to complete the tasks might be a somewhat conservative measure of facial affect recognition impairments, it is unclear as to the appropriateness of using the published normative data to compute the z-scores with the modification of the presentation time. Future research should therefore investigate how presentation time durations might influence facial affect recognition performance. Such information would be essential to the progress of facial affect recognition research in TBI.

Other limitations in the study concern the sample selection, methodology, and statistical procedure followed. Various selection criteria were used that eliminated many persons with TBI. Most of the social and interpersonal functioning variables were measured by self-report. People with brain injury might be unable or under-report for a variety of reasons such as difficulty in recall, social desirability and poor self-awareness. Self-report measures should therefore be supplemented by non-self-report measures where possible. Autonomic measures to assess participants' physiological affective responsiveness might also be a useful tool in tracking treatment progress. This idea is supported by recent work by Quintana and colleagues (in press) which has shown through the use of a heart rate monitor that an autonomic nervous system as indexed by heart rate variability links to emotion recognition in healthy adults. The fact that the cognitive measures used at pre-test were readministered following treatment but not at follow-up, is a further limitation in this study. If this information had been collected it would have allowed gains made by participants who had received the Faces training to be distinguished, at the six-month follow-up, from any more general improvement in cognitive ability occurring in the course of and after the treatment. Such information would add important knowledge to current theoretical debate on the nature of the facial affect recognition–cognition linkage. In addition, this study did not include theory of mind measures, an omission which could provide valuable information regarding whether the *Stories* intervention encompasses affective or cognitive theory of mind (or indeed whether it includes both of these). Moreover, several clinical studies have shown that impaired theory of mind is associated with deficits in social functioning (Brüne, Schaub, Juckel, & Langdon, 2011; Carla, 2008; Peterson, Garnett, Kelly, & Attwood, 2009). Brune, Schaub, Juckel and Langdon (2011), for instance, found that mental state attribution (also known as theory of mind) was the best predictor of social skills in a sample of 69 patients with schizophrenia, accounting in that sample for about 20–30% of the social performance scores. It is therefore unclear whether reduced theory of mind capacity may underpin the impact of affect recognition on social functioning in this study. Finally, in this study, the statistics were not adjusted for multiple comparisons, which does increase the likelihood of chance significant findings. Thus, the potential effects of multiple comparisons should be considered when interpreting these results.

Such limitations notwithstanding, the study has a number of strengths. These include well-controlled clinical trial design, the use of randomization and allocation concealment, blinded outcome assessment, implementing designs with sufficient follow-up to evaluate treatment effect, a thorough neuropsychological evaluation; and inclusion of informants' ratings preventing sole reliance on participants' self-reporting. It is worth noting that all participants completed the treatment; highly encouraging in itself, given that recruiting and retaining TBI patients as participants in clinical search trials is known to be difficult and challenging. The tenacity displayed by participants may indicate that they might have perceived the benefits of the interventions offered by the current study.

While evidence suggests that facial affect recognition deficits in people with TBI can be regained through targeted training, there is a clear need for future research to determine which specific components of the intervention are most responsible for the observed changes, and the extent to which these interventions fit with the current theoretical models of facial affect recognition. Such knowledge may strengthen future studies by enabling the development of more efficient and targeted training programmes.

Affect recognition training interventions may also benefit from advances in our ability to study and modify physiological activity.[14] In recent years, techniques such as biofeedback have increasingly been used for such purposes. There is evidence from clinical studies that modulation of physiological processes can induce gains in affective functioning, and may also augment emotion recognition accuracy (Kim & Andre, 2008; McCabe, Loughland, Hunter, Lewin, & Carr, 2010). An interesting future development

[14] Physiological activity often applies to measure of the parasympathetic nervous system; for example, electrodermal acidity, heart and blood circulation, respiration, muscular activity, etc.

therefore would be to incorporate a portable biofeedback in the affect recognition training in TBI. This approach could prove instrumental in facilitating motivation (e.g. visual feedback from the physiological signals) and neuroplasticity, which may in turn promote greater affect recognition recovery. Another area for future investigation would be the use of dynamic stimuli in a training programme (e.g., video stimuli). Recent researchers have shown that the dynamic manifestations of emotion are recognized more accurately than the static ones, as they may more easily cause spontaneous facial mimicry and higher levels of simulation activation (Buccino et al., 2001; Johnston et al., 2010).

Several questions worthy of future investigation arise from the present study. For example, does the presence of facial affect recognition deficits put one at greater risk of developing impairments in other aspects of social cognition, particularly theory of mind and empathy? Another question is whether affect recognition training alters the neural subtracts associated with emotion recognition? Are there contextual and/or individual difference factors in TBI that stimulate or constrain neuroplastic changes in response to affect recognition training? The question of whether affect recognition training periods can be used as stand-alone treatments or whether they should be embedded with other psychosocial interventions to improve social outcomes is a further matter for clarification. Two additional questions invite investigation: one, whether the duration and intensity of training have a specific effect on patients; the other, which patients with TBI are most likely to benefit from affect recognition training? Additional neuroimaging studies using advance techniques may cast light on some of these questions.

Conclusion

On balance, the current study suggests that *Faces* training is effective in enhancing affect recognition skills in people with TBI. Additionally, it indicates that *Faces* treatment may produce enduring effects. Although this training did not result in significant improvement in participants' social functioning, this study shows that *Faces* training may increase participants' empathy behaviours and raises a possibility that the treatment may modulate affect recognition by increasing emotional awareness. With regard to the *Stories* intervention, the findings of this study does not provide support for its efficacy in enhancing emotional inference abilities, although further research in this area is called for. This study work highlights the possible importance of considering other psychosocial strategies in the treatment, as well as the involvement of significant others. It also raises the possibility that affect recognition and depression may not be as closely connected after TBI as previously suggested.

While conclusions arrived at as a result of this study support the efficacy of the *Faces* training in helping patients with TBI acquire affect recognition skills, additional investigation is needed to provide further support for these findings, as well as to verify the treatment's durability over a longer period of time. It is also critical that the long-term benefits of affect recognition for other aspects of social cognition be investigated, and the degree to which the training transfers to patients' everyday social life. In addition to objective social functioning measures, future research should also include a qualitative component such as interviews to explore how participants' quality of life changes after the treatment. This would further attest to the benefits of the treatment programme for other aspects of patients' well-being: their self-esteem, for example. Clinicians and researchers should be encouraged to work together to produce and use more rigorous performance measures that tap into a wider range of specific social and affect recognition competencies. It is important to understand the biological, cognitive and environmental mechanisms through which *Faces* training intervention influences TBI patients' treatment outcomes and subsequently their social behaviours. Expansion of such knowledge requires large TBI samples, longitudinal intervention studies, and a multi-method approach with a multidisciplinary perspective. Single case experimental designs should also be considered to provide further meaningful information about plausible application in frontline clinical services.

Chapter 9: Study Two

The relationship between facial affect recognition and cognitive functioning after traumatic brain injury

Yim, J., Babbage, D. R., Zupan, B., Neumann, D., & Willer, B. (Accepted pending minor revisions). The relationship between facial affect recognition and cognitive functioning after traumatic brain injury. *Brain Injury*.

Abstract

There is considerable evidence suggesting that facial affect recognition and cognitive functions are impaired in many people with moderate to severe traumatic brain injury (TBI). However, little is known about the relationship between these two domains in the TBI population. This study investigated the relationship between facial affect recognition and cognitive functioning in 75 adults with moderate to severe TBI. Participants were administered three facial affect recognition tests and a computerized cognitive test battery that assessed seven cognitive domains. Deficits in facial affect recognition were significantly correlated with impairments in non-verbal memory, working memory, speed of processing, verbal memory, and verbal delayed memory. No significant relationship was found between executive dysfunction and facial affect recognition impairments. Nonverbal memory, working memory, and speed of processing significantly predicted overall facial affect recognition performance. We conclude that impairment in several cognitive processes may contribute to facial affect recognition deficits in TBI, in particular nonverbal memory, working memory and speed of processing. Furthermore, executive functioning may not be a critical factor in facial affect recognition, but would most likely to be very important in deciding what to do once facial affect is perceived.

The relationship between facial affect recognition and cognitive functioning after traumatic brain injury

Impaired facial affect recognition and cognitive deficits are prevalent in people with moderate to severe TBI (D R Babbage et al., 2011; Dikmen et al., 2009; Radice-Neumann et al., 2007; Roebuck-Spencer & Sherer, 2008). However, the relationship between facial affect recognition and various aspects of cognitive impairment resulting from TBI has yet to be fully determined. Better understanding of these associations may clarify brain/behaviour relationships in TBI and better define specific targets for augmenting social skills. For this study, *cognitive functioning* refers to general cognitive abilities such as language, attention, memory, and executive functioning that do not involve any affective component.

A growing body of research indicates people with TBI are impaired in a variety of facial affect recognition tasks (McDonald et al., 2003; Radice-Neumann et al., 2007; Spell & Frank, 2000; C. Williams & Wood, 2010), and as many as 39% of people with moderate to severe TBI may be affected (D R Babbage et al., 2011). Difficulty interpreting how others are feeling and thinking from facial expression cues may contribute to poor social functioning after TBI (Driscoll et al., 2011). Indeed, several studies have demonstrated that such facial affect recognition deficits are associated with reduced social functioning (Knox & Douglas, 2009; Watts & Douglas, 2006).

Despite the substantial evidence for both impaired facial affect recognition and cognitive deficits in TBI, studies directly examining the relationships between these two domains in people with TBI are sparse. Evidence examining the links between emotion recognition and cognitive functioning in other clinical and healthy populations is mixed. Some studies found that emotion recognition was related to working memory (Phillips, Channon, Tunstall, Hedenstrom, & Lyons, 2008), executive functions (Henry et al., 2006; Lee, Lee, Kweon, Lee, & Lee, 2009), speed of processing, attention, verbal memory (Henry et al., 2009a; Mathersul et al., 2009; Sachs et al., 2004) and even language abilities (Barrett, Lindquist, & Gendron, 2007; Gendron, Lindquist, Barsalou, & Barrett, 2012). However, others failed to find any associations between emotion recognition and particular cognitive functions (Pinkham et al., 2003; Shamay-Tsoory et al., 2007).

Findings from three studies with patients with TBI are also equivocal. Allerdings and Alfano (2006) investigated the role of attention and memory on facial affect recognition in a study of 11 individuals with moderate to severe TBI and 13 healthy controls. Participants were required to identify affect from faces and their cognitive abilities were evaluated using a neuropsychological battery. Emotion recognition performance was most significantly correlated with measures of language and verbal learning indices (i.e., Hopkins Verbal Learning Test and the Controlled Oral Word Association Test), suggesting that emotion recognition deficits might partly be a consequence of reduced verbal ability.

Two subsequent studies, however, challenged these assertions. Using a case series design, Tonks et al. (2008) examined whether cognitive impairments might underpin emotion processing difficulties in seven children with TBI. Emotion recognition abilities were assessed using the Florida Affect Battery facial identity discrimination, facial affect discrimination, facial affect naming, facial affect selection, and facial affect matching tasks. Cognitive domains targeted were abstract thinking/flexibility (Verbal Letter Fluency), planning and problem-solving (Tower Test), attention (Number-Letter Switching), working memory (Digit Span) and visual processing speed (Symbol Search). The findings suggested that facial affect recognition could be impaired in the presence of intact cognitive abilities. In line with this, Spikman et al. (2012) reported a wide range of social cognition measures (emotion recognition, theory of mind, and empathy) were not related to particular general cognitive functions (such as memory, mental speed, attention, and executive functioning) in 28 people with moderate to severe TBI. However, severity of injury, as determined by the duration of post-traumatic amnesia and Glasgow Coma Scale score, was found to be a good predictor of poor emotion recognition task performance. It appears that facial affect recognition impairments in TBI may be a factor of either general cognitive impairments or a specific deficit or possibly both.

Current evidence on the facial affect recognition–cognition link remains tenuous. Two limitations of previous studies are small sample size and a limited range of facial affect recognition tasks. The discrepancy between the outlined studies may be partly attributed to methodological differences such as the type of the emotion recognition tasks used. More research is required to understand the extent to which general cognitive factors are associated with social cognitive domains and in particular facial affect recognition in

TBI. Also, given that cognitive factors may contribute to impaired facial affect recognition, it would be useful to explore their possible influence. Such knowledge could be a crucial step towards developing targeted treatments for facial affect recognition adapted to this clinical group.

To address the limitations of previous studies, the present study investigated the relationship between facial affect recognition and cognitive functioning in people with TBI, using a larger sample size and multiple facial affect recognition tasks.

Method

Participants

The data were drawn from an international randomized clinical trial examining the efficacy of two new treatments to improve facial affect recognition in people with TBI. The authors examined the relationship between facial affect recognition and cognitive function observed in participants' pre-treatment assessments. Participants were recruited from facilities providing brain injury rehabilitation services and support groups across three sites: Charlotte, North Carolina, USA; St. Catharines, Ontario, Canada; and Wellington/Palmerston North in New Zealand.

Seventy-five participants with TBI (58 men, 17 women) met the initial screening criteria of the wider study:

1. Aged 18-65 years.
2. Had sustained a moderate or severe TBI as determined by a Glasgow Coma Scale score less than or equal to 12, or post-traumatic amnesia or loss of consciousness of at least 24 hours.
3. Aged eight or older at the time of injury.
4. At least one year post injury.
5. Scored at least 1.5 standard deviations below the age-group norm on the Diagnostic Assessment of Nonverbal Affect-2, Adult-Faces, a standardized assessment of facial affect recognition. (To meet the criteria for the subsequent clinical trial, participants had to maintain a score of at least one standard deviation below the norm at pre-testing two weeks later.)
6. Scored at least 75% accuracy on the Discourse Comprehension Test (an asssessment for comprehension; Brookshire & Nicholas, 1993).

Exclusion criteria included impaired vision or hearing, pre-injury psychiatric history, and substance dependence.

The mean age of participants was 40.64 years (*SD* = 11.3) and they were on average 10.7 years post injury (*SD* = 8.4 years). The mean period of education was 12.7 years (*SD* = 2.5). Most of the participants had sustained severe TBI (n = 73 severe, n = 2 moderate). Data on post-traumatic amnesia were available for most participants (n = 62). Fifty-eight of these participants had PTA greater than seven days and the other four had PTA between one and six days. Following the pre-test assessment, 70 out of these 75 participants took part in the treatment trial that constituted the wider study. All the participants gave their informed consent for the study, which was approved by the local ethics committees at each site.

Measures

Facial affect recognition

Three tasks designed to assess facial affect recognition were administered to each participant.

*The Diagnostic Analysis of Nonverbal Accuracy 2-Adult Fa*ces (DANVA2-Adult Faces; Nowicki & Duke, 1994) assesses affect recognition from facial expressions. It consists of 24 photographs of faces that vary in gender, ethnicity, emotion, and emotion intensity. Each photo was presented on a computer screen for 15 seconds. This was longer than the standard presentation time of two seconds in order to minimise the effect of information processing speed and visuoperceptual abilities on performance. Thus, this was a conservative test of impairment since this may have increased scores for our participants relative to the norms. Participants were asked to choose one of four emotion labels listed below the picture that best described how the person in the photograph was feeling (i.e., happy, sad, angry, or fearful). The DANVA2-Adult Faces has been reported to be a valid and reliable measure of emotion recognition (Cherniss, 2010). It had an average internal consistency of .78 across ten studies (Nowicki, 2010). Test-retest reliability was .81 in a study with persons having TBI (Spell & Frank, 2000).

The Facial Affect Naming (subtest 3) of the Florida Affect Battery (FAB-3 Facial Affect Naming; Bowers et al., 1991) assesses affective labelling for 20 black and white photographs of female faces. The participant’s task was to choose the most appropriate label from a list of five emotional descriptors: happy, sad, angry, fearful, or neutral. As per the instructions, there was no time limit for the presentation of these faces. The test-retest reliability of the FAB ranges between .89 and .97 (Bowers et al., 1991). It has also been found to effectively differentiate between performance levels of healthy adults and adults with brain injury (Middleton, 2001).

The Social-Emotional Cognition Task, subtest of the CogState (SECT; CogState Ltd., Melbourne, Australia) assesses aspects of social cognition. It consists of 48 trials consisting of three types of stimuli: computer generated male faces depicting facial expressions; pictures of male and female eyes displaying emotions; and eye gaze direction (a control task). As this was a discrimination task, SECT items are not formally labelled as to which emotion they depict, but represent typical emotions. Each stimulus was presented on a computer screen for 15 seconds. For each trial the participant had to choose the picture that was different out of a group of four by clicking on it with a mouse. This task was newly added to the CogState battery and at the time of the current study, reliability and validity data are yet to be published.

Cognitive assessment

The CogState test battery comprises a set of independent tasks that assess a range of cognitive abilities. For this study we used the seven tasks that evaluated domains of cognitive function known to be sensitive to cognitive changes following TBI. They included indices of verbal learning (International Shopping List Task), verbal delayed memory (International Shopping List Task-Delayed Recall), speed of processing (Detection Task), attention/vigilance (Identification Task), visual working memory (One Back Task), non-verbal memory (Continuous Paired Association Learning Task) and executive functioning (Set-Shifting Task). The CogState battery is sensitive to mild cognitive impairments from a variety of causes including TBI (Darby et al., 2002; Maruff et al., 2009) and has minimal practice effects (Falleti et al., 2006). The validity and reliability of the battery has been established from over 100 peer-reviewed scientific articles (see www.cogstate.com).

Procedure

Potential participants were assessed by a trained member of the research team in a quiet room. The screening lasted about two hours, including short breaks. Participants completed tests assessing a wide range of domains including facial affect recognition, empathy, and social functioning for the wider clinical trial; only the measures above are reported here. Participants who passed the initial screening phase were again assessed within 15-28 days of the screening visit. This second assessment provided a further confirmation of impaired facial affect recognition functioning, while being a long enough interval to control for the most acute practice effects. (Any practice effects would have served to improve performance, thus reducing the likelihood participants would remain eligible for the trial.) The materials and procedures in the pre-treatment assessment were identical to those in the initial screening except additional measures were included such as tests to assess cognitive abilities. Order of the DANVA2-Adult Faces and FAB-3 were counterbalanced and administered at both screening and pre-test. The CogState was administered at the end of the pre-test assessment only. Participants' demographic and medical information was also collected. As the DANVA2-Adult Faces and FAB-3 Facial Affect Naming were administered at screening and pre-test, an average across the two assessment points was used in all analyses as the 'baseline' measure. As the CogState was administered only at the pre-treatment assessment, the SECT score is based on this single assessment point.

Missing Data

With the exception of the executive function domain, missing data on each of the other cognitive domains were less than 4% of the sample. The primary reason for these missing data was due to participants' refusal to complete the task, citing task difficulty. However, on the executive function domain, there were missing data for 40 participants (about 30% of the sample). In all cases, the missing data represented software problems in recording participant responses with the set-shifting task. As such, these missing data were likely to be missing at random and therefore not create a biased sample. For the missing data, the multiple imputation procedure in SPSS (IBM Corporation, Somers, NY, USA) was used to estimate the missing cognitive values. SPSS default setting of five imputations was used (see Schafer, 1999, for a discussion).

Statistical Analyses

Data analysis was performed using SPSS version 20 (IBM Corporation, Somers, NY, USA). Statistical significance was set at an alpha level of .05. A series of simple linear regression analysis were performed to assess the relationship between cognitive function tasks and participants' performance on facial affect recognition tasks. Three separate stepwise multiple regression analyses were also conducted to explore the best set of cognitive predictors of each of the facial affect recognition measures and to exclude those predictors that did not explain any additional variance in the facial affect recognition over and above the initial best predictors. All analyses were performed on the imputed dataset and the pooled results were reported. SPSS reports pooled results for only a limited range of simpler analyses, however. For analyses without the pooled estimates, the range values from the five datasets were provided.

Results

Preliminary analyses were conducted to ensure there was no violation of regression analysis assumptions. Inter-correlations were calculated between the three facial affect recognition measures. The DANVA2-Adult Faces was significantly related with the FAB-3 Facial Affect Naming, $r(75) = .57$, $p < .001$ and the SECT, $r(75) = .41$, $p < .001$. The FAB-3 was correlated significantly with the SECT, $r(75) = .44$, $p < .001$. The correlation coefficients between the cognitive functioning measures and the facial affect recognition measures are presented in Figure 17. All three facial affect recognition measures (DANVA2-Adult Faces, FAB-3 Facial Affect Naming, and SECT) were significantly correlated with nonverbal memory, r = .25 to .46, all $p < .05$, working memory, r = .31 to .43, all $p < .05$, verbal learning, r = .26 to .30, all p <. 05, verbal delayed memory, r = .24 to .32, all p <. 05, and speed of processing, r = .26 to .37, all $p < .05$. However, attention was significantly correlated with the FAB-3 Facial Affect Naming only, $r = .35$, $p = .003$. Executive control was not significantly related with any of the three facial affect recognition measures (DANVA2-Adult Faces: $r = .03$, $p = .80$; FAB-3 Facial Affect Naming: $r = .09$, $p = .57$; SECT: $r = .15$, $p = .38$), suggesting that this capacity, an aspect of executive functioning may not contribute to facial affect recognition in TBI population. Overall, the SECT tended to have stronger correlations with cognitive variables than either the DANVA2-Adult Faces or the FAB-3 Facial Affect Naming, although the reverse pattern was observed for the attention domain.

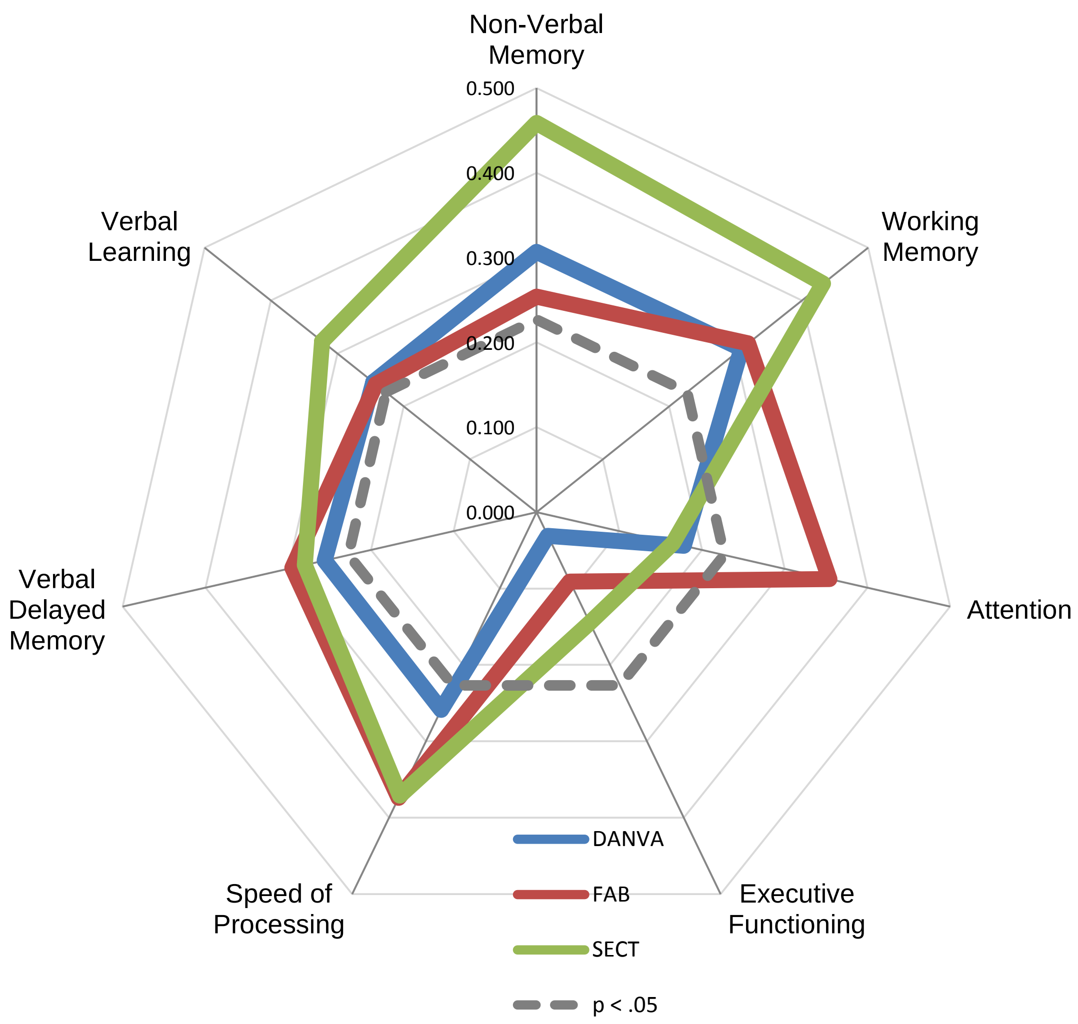


Figure 17. Raw correlations between facial affect recognition and cognitive variables.

Table 9 displays the unstandardized regression coefficients, the standard error for each unstandardized regression coefficient and the standardized regression coefficients for the cognitive functions as predictors with performance on facial affect recognition as the criterion.

Table 9

Simple Regression Analysis for Prediction of Facial Affect Recognition Measures by Cognitive Variables

	DANVA2-AF				FAB3				SECT			
	B	SE	β	*p*	*B*	SE	β	*p*	*B*	SE	β	*p*
Nonverbal memory	-0.025	0.009	-.307	.006**	-0.017	0.008	-.253	.025*	-0.002	0.001	-.460	.000***
Working memory	3.489	1.281	.308	.007**	2.864	0.998	.319	.004**	0.313	0.078	.432	.000***
Attention	-5.838	3.824	-.177	.130	-9.241	2.890	-.353	.001**	-0.348	0.250	-.165	.165
Executive functioning	0.004	0.014	-.035	.802	-0.008	0.014	-.009	.570	-0.001	0.001	-.144	.380
Speed of processing	-5.543	2.439	-.260	.023*	-6.355	1.856	-.373	.001**	-0.508	0.155	-.370	.001**
Verbal learning	0.130	0.058	.256	.025*	0.119	0.045	.294	.009**	0.009	0.004	.280	.015*
Verbal delayed memory	0.256	0.119	.246	.032*	0.199	0.097	.242	.039*	0.022	0.008	.322	.005**

Note. DANVA2-AF = The Diagnostic Analysis of Nonverbal Accuracy 2–Adult Faces, FAB3 = Facial Affect Naming subtest of the Florida Affect Battery, SECT = Social-Emotional Cognition Task subtest of the CogState, *B* = unstandardized regression coefficient, SE = standard error, β = standardized regression coefficient. * $p < .05$, ** $p < .01$,*** $p < .001$.

Results of the stepwise multiple regression analyses revealed that nonverbal memory, $\beta = .31$, $p = .007$, and working memory, $\beta = .31$, $p = .007$ as the only significant predictors in the DANVA2-Adult Faces scores, whereas working memory, $\beta = .22$, $p = .04$, speed of processing, $\beta = .34$, $p = .002$, and verbal learning, $\beta = .25$, $p = .03$, were the three significant predictors in the FAB-3 Facial Affect Naming scores. For the SECT scores, nonverbal memory, $\beta = .41$, $p < .001$, and speed of processing, $\beta = .27$, $p = .008$, were the only significant predictors. In these analyses the other cognitive functions failed to predict unique variance in each of the facial affect recognition measures over and above the effects of the stated significant predictors. Because age is known to be negatively correlated to some extent with reduced cognitive efficiency, it could potentially confound the relationship between cognitive functioning and facial affect recognition impairments. Injury severity was not used as a covariate in the main analysis because the vast majority of the participants had severe injuries. All of the analyses were therefore re-run controlling for age. The overall pattern of results did not substantially change; the same significant predictors were obtained on all analyses, although the magnitudes of all coefficients were slightly strengthened.

Discussion

The aim of this study was to examine whether facial affect recognition impairments were related to other areas of cognitive functioning among people with moderate to severe TBI. This study is the first to use three different facial affect recognition tasks along with a computerized cognitive battery to test the association between the two domains. There were three main findings. Firstly, correlation and simple linear regression analyses showed that facial affect recognition deficits were most related to nonverbal memory, working memory, speed of processing, verbal delayed memory, and verbal learning deficits. These associations were generally small to moderate, and varied among the three facial affect recognition measures, with the SECT having the strongest correlation. Overall, these results dovetail with findings of previous studies suggesting that some aspects of cognitive functioning may partly account for facial affect processing.

Secondly, stepwise multiple regression analyses indicate that overall problems in facial affect recognition of people with TBI may be best predicted by working memory and speed of processing. This finding is consistent with Adolphs (2002), Phillips et al.

(2008), and Mathersul et al. (2009) who suggested that working memory and speed of processing and nonverbal memory abilities are integral to the perception of emotions. For TBI patients who have difficulties in working memory or deficits in speed of processing, it is likely that inability to hold affective information on line and/or reduced capacity to process emotional cues quickly may impair their ability to identify facial affect accurately. For those who have difficulties in nonverbal memory, it is possible that a reduced capacity to retain and/or retrieve visual details of particular facial features may interfere with emotional processing. However, given that working memory, speed of processing and nonverbal memory are believed to be intimately linked with other cognitive domains, it is also possible that impairment in these three domains may in turn impair other cognitive processes required for the processing of facial displays of emotion. For example, deficits in working memory and/or nonverbal memory may impede TBI patients accessing the language component to select appropriate concept knowledge from memory and inhibit inappropriate concept knowledge as they attempt to decipher emotions signalled by facial expression. Reduced information speed processing could hinder some individuals to scan, attend, and collect visual information and consequently in making correct emotion judgments. Alternatively or additionally, facial affect recognition after brain injury could be reliant on cognitive routes that compensate for a possible loss of spontaneity in recognising facial affect in others. Further work is clearly warranted to better understand how specific cognitive domains contribute to facial affect recognition impairments.

The relatively low convergent validity correlation between the three measures of facial affect recognition and the variation of the strength of relationship observed between the three facial affect recognition measures and cognitive variables may possibly be explained by the inherent nature of the tasks, type of decision required, task complexity and emotional stimuli composition. The SECT, for example, differs from the other two labelling tasks because it requires participants to perceptually compare four computer-generated faces and isolated eyes, from which they must identify the outlier. This may be more challenging and draw on greater cognitive resources. The task of distinguishing how one emotional stimulus differs from three others could possibly involve more effortful perceptual and cognitive processing (i.e., divided attention and working memory to hold information about one stimulus in mind while looking at the other three stimuli). As to the reason behind attention being associated with the FAB-3 Facial

Affect Naming only, we speculate that FAB-3 Facial Affect Naming may draw more attention resources due to its black and white pictures which resemble real-world emotional faces less than the DANVA2-Adult Faces and SECT where the pictures are in colour (Of course, the same argument has likewise been made for the value of dynamic assessment tools like the Awareness of Social Inference Test, TASIT, over static images; McDonald et al., 2003).

The third main finding, the lack of a significant relationship between executive control skills and the ability to accurately identify facial expression of emotions, is surprising given that several studies have found executive function to be a key predictor of emotion recognition deficits (e.g., Lee et al., 2009). It is possible that the simplicity of the facial affect recognition tasks (i.e., DANVA2-Adult Faces and FAB-3 Facial Affect Naming) in our study did not require as much cognitive effort as other measures that use more than four basic emotions, thus attenuating the demand for executive control resources. However, it may be that the Set-Shifting measure of the CogState used in the current study is not sensitive to the aspects of executive functioning that relate to facial affect recognition, in comparison to measures used in earlier studies (e.g., the Verbal Fluency Test and the Wisconsin Card Sorting Test; Henry et al., 2006; Lee et al., 2009). Nonetheless, our data raise the question of whether executive dysfunction is a major contributor of impaired facial affect recognition in TBI or whether such difficulties only have a more limited contributory role.

Several limitations of the present study are noted. The screening process for the wider clinical trial prior to the CogState being administered ensured the current study only included people with impairments in facial affect recognition. The resulting range restriction may have artificially constrained observed correlations—true correlations between the variables in the full TBI population may be stronger. Findings from this study are correlational so causal inferences can only be speculative. It would be premature to assume that the underlying mechanisms for impaired performance of facial affect recognition tasks are necessarily the same for all people with TBI. Our samples have not been matched for type of injuries, and it could be argued that this variable may have a potential confounding effect on the results. We did not control for the influence of medication on cognitive performance, although the heterogeneous set of medication regimens precluded us from establishing which medication regime contributed most to cognitive performance. Lastly, there are other contributing factors such as depression and motivation that could be investigated in terms of their influence on the relationship between facial affect recognition and cognitive functioning.

Findings of this study have both theoretical and clinical implications. The interrelationships between facial affect recognition deficits and cognitive functioning necessitate a clear theoretical model of how changes in aspects of cognitive function and facial affect recognition are linked to social outcomes in people with TBI. Given the magnitude and frequency of facial affect difficulties in people with TBI and the potential associated social difficulties, it is recommended that clinical assessments include measures evaluating facial affect recognition abilities alongside traditional neuropsychological measures. There is also a pressing need to develop effective intervention strategies to improve functional facial affect recognition for people with TBI. This may involve tailoring the facial affect recognition intervention to each individual’s level of cognitive functioning (e.g., reducing working memory load) so as to maximise their ability to benefit from the training.

Considerable work remains to be done with respect to: (1) determining whether cognitive processes underlying facial affect recognition deficits in TBI are similar to or different from the difficulties experienced by other clinical groups such as people with autism; (2) exploring whether spontaneous improvement in cognitive functioning during recovery is accompanied by improvements in facial affect recognition; and (3) uncovering the neural basis of facial affect recognition deficits in TBI. Additional research using other approaches such as functional imaging, as well as further studies of the present kind that employ larger sample sizes, using emotional stimuli that more closely resemble real life, may be useful to clarify these issues.

In conclusion, the present study shows that deficits in several cognitive processes are correlated with facial affect recognition deficits in TBI, particularly nonverbal memory, working memory, and speed of processing. This study raises the possibility that executive functioning may not be a critical cognitive factor in facial affect recognition, though may remain important in deciding what to do once facial affect is perceived. It is possible that the makeup of emotional stimuli and task complexity of facial affect recognition tasks may influence these emotion recognition–cognition links. We need more work to understand the actual mechanisms underlying facial affect recognition processing deficits so that effective interventions might be devised to ameliorate or at least compensate for them.

Declaration of Interest

Supported by the National Institute on Disability and Rehabilitation Research (grant no. H133G080043). The data presented in this study were collected as part of a registered clinical trial—ClinicalTrials.gov identifier: NCT00283153.

References

Adolphs, R. (2002). Recognizing emotion from facial expressions: psychological and neurological mechanisms. *Behavioral and Cognitive Neuroscience Reviews, 1*, 21-61.

Allerdings, M. D., & Alfano, D. P. (2006). Neuropsychological correlates of impaired emotion recognition following traumatic brain injury. *Brain and Cognition, 60*, 193-194.

Babbage, D. R., Yim, J., Zupan, B., Neumann, D., Tomita, M. R., & Willer, B. (2011). Meta-analysis of facial affect recognition difficulties after traumatic brain injury. *Neuropsychology, 25*, 277-285.

Barrett, L. F., Lindquist, K. A., & Gendron, M. (2007). Language as context for the perception of emotions. *Trends in Cognitive Sciences, 11*, 327-331.

Bowers, D., Blonder, L. X., & Heilman, K. M. (1991). *Florida Affect Battery*. Gainesville: University of Florida.

Brookshire, R. H., & Nicholas, L. E. (1993). *The discourse comprehension test*. Tucson, AZ: Communication Skill Builders/The Psychological Corporation.

Cherniss, C. (2010). Emotional intelligence: towards clarification of a concept. *Industrial and Organizational Psychology, 3*, 110-126.

Darby, D., Maruff, P., Collie, A., & McStephen, M. (2002). Mild cognitive impairment can be detected by multiple assessments in a single day. *Neurology, 59*, 1042-1046.

Dikmen, S. S., Corrigan, J. D., Levin, H. S., Machamer, J., Stiers, W., & Weisskopf, M. G. (2009). Cognitive outcome following traumatic brain injury. *Journal of Head Trauma Rehabilitation, 24*, 430-438.

Driscoll, D. M., Dal Monte, O., & Grafman, J. (2011). A need for improved training interventions for the remediation of impairments in social functioning following brain injury. *Journal of Neurotrauma, 28*, 319-326.

Falleti, M. G., Maruff, P., Collie, A., & Darby, D. G. (2006). Practice effects associated with the repeated assessment of cognitive function using the CogState battery at 10-minute, one week and one month test-retest intervals. *Journal of Clinical and Experimental Neuropsychology, 28*, 1095-1112.

Gendron, M., Lindquist, K. A., Barsalou, L., & Barrett, L. F. (2012). Emotion words shape emotion percepts. *Emotion, 12*, 314-325.

Henry, J. D., Phillips, L. H., Beatty, W., McDonald, S., Longley, W. A., Joscelyne, A., & Rendell, P. G. (2009). Evidence for deficits in facial affect recognition and theory of mind in multiple sclerosis. *Journal of the International Neuropsychological Society, 15,* 277-285.

Henry, J. D., Phillips, L. H., Crawford, J. R., Ietswaart, M., & Summers, F. (2006). Theory of mind following traumatic brain injury: the role of emotion recognition and executive dysfunction. *Neuropsychologia*, *44*, 1623-1628.

Knox, L., & Douglas, J. (2009). Long-term ability to interpret facial expression after traumatic brain injury and its relation to social integration. *Brain and Cognition*, *69*, 442-449.

Lee, S. J., Lee, H. K., Kweon, Y. S., Lee, C. T., & Lee, K. U. (2009). The impact of executive function on emotion recognition and emotion experience in patients with schizophrenia. *Psychiatry Investigation, 6*, 156-162.

Maruff, P., Thomas, E., Cysique, L., Brew, B., Collie, A., Snyder, P., & Pietrzak, R. H. (2009). Validity of the CogState brief battery: relationship to standardized tests and sensitivity to cognitive impairment in mild traumatic brain injury, schizophrenia and aids dementia complex. *Archives of Clinical Neuropsychology, 24*, 165-178.

Mathersul, D., Palmer, D. M., Gur, R. C., Gur, R. E., Cooper, N., Gordon, E., & Williams, L. M. (2009). Explicit identification and implicit recognition of facial emotions: II. Core domains and relationships with general cognition. *Journal of Clinical and Experimental Neuropsychology, 31*, 278-291.

McDonald, S., Flanagan, S., Rollins, J., & Kinch, J. (2003). TASIT: A new clinical tool for assessing social perception after traumatic brain injury. *The Journal of Head Trauma Rehabilitation, 18,* 219-238.

Middleton, J. A. (2001). Brain injury in children and adolescents. *Advances in Psychiatric Treatment*, *7*, 257-265.

Nowicki, S. (2010). *Manual for the receptive tests of the Diagnostic Analysis of Nonverbal Accuracy 2*. (Unpublished manuscript). Department of Psychology, Emory University, Atlanta, GA.

Nowicki, S., & Duke, M. (1994). Individual differences in the nonverbal communication of affect: the diagnostic analysis of nonverbal accuracy scale. *Journal of Nonverbal Behavior, 18*, 9-35.

Phillips, L. H., Channon, S., Tunstall, M., Hedenstrom, A., & Lyons, K. (2008). The role of working memory in decoding emotions. *Emotion, 8*, 184-191.

Pinkham, A. E., Penn, D. L., Perkins, D. O., & Lieberman, J. (2003). Implications for the neural basis of social cognition for the study of schizophrenia. *The American Journal of Psychiatry, 160*, 815-824.

Radice-Neumann, D., Zupan, B., Babbage, D. R., & Willer, B. (2007). Overview of impaired facial affect recognition in persons with traumatic brain injury. *Brain Injury, 21*, 807-816.

Roebuck-Spencer, T., & Sherer, M. (2008). Moderate and severe traumatic brain injury. In J. E. Morgan & J. H. Ricker (Eds.), *Textbook of clinical neuropsychology* (pp. 411-429). New York: Taylor & Francis.

Sachs, G., Steger-Wuchse, D., Kryspin-Exner, I., Gur, R. C., & Katschnig, H. (2004). Facial recognition deficits and cognition in schizophrenia. *Schizophrenia Research, 68*, 27-35.

Schafer, J. L. (1999). Multiple imputation: a primer. *Statistical Methods in Medical Research, 8*, 3-15.

Shamay-Tsoory, S. G., Shur, S., Barcai-Goodman, L., Medlovich, S., Harari, H., & Levkovitz, Y. (2007). Dissociation of cognitive from affective components of theory of mind in schizophrenia. *Psychiatry Research*, *149*, 11-23.

Spell, L. A., & Frank, E. (2000). Recognition of nonverbal communication of affect following traumatic brain injury. *Journal of Nonverbal Behavior*, *24*, 285-300.

Spikman, J. M., Timmerman, M. E., Milders, M. V., Veenstra, W. S., & van der Naalt, J. (2012). Social cognition impairments in relation to general cognitive deficits, injury severity and prefrontal lesions in traumatic brain injury patients. *Journal of Neurotrauma, 20*, 101-111.

Tonks, J., Williams, H. W., Frampton, I., Yates, P., Wall, S. E., & Slater, A. (2008). Reading emotions after childhood brain injury: case series evidence of dissociation between cognitive abilities and emotional expression processing skills. *Brain Injury*, *22*, 325-332.

Watts, A. J., & Douglas, J. M. (2006). Interpreting facial expression and communication competence following severe traumatic brain injury. *Aphasiology, 20*, 707-722.

Williams, C., & Wood, R. L. (2010). Impairment in the recognition of emotion across different media following traumatic brain injury. *Journal of Clinical and Experimental Neuropsychology*, *32*, 113-122.

DRC 16

MASSEY UNIVERSITY
GRADUATE RESEARCH SCHOOL

STATEMENT OF CONTRIBUTION
TO DOCTORAL THESIS CONTAINING PUBLICATIONS

(To appear at the end of each thesis chapter/section/appendix submitted as an article/paper or collected as an appendix at the end of the thesis)

We, the candidate and the candidate's Principal Supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the candidate's contribution as indicated below in the *Statement of Originality*.

Name of Candidate: Jackki Yim Hoon Eng

Name/Title of Principal Supervisor: Dr Duncan Babbage

Name of Published Research Output and full reference:

Yim, J., Babbage, D. R., Zupan, B., Neumann, D., & Willer, B. (Accepted pending minor revision.) The relationship between facial affect recognition and cognitive functioning after traumatic brain injury. Brain Injury.

In which Chapter is the Published Work: Chapter 9

Please indicate either:

- The percentage of the Published Work that was contributed by the candidate:

  and / or

- Describe the contribution that the candidate has made to the Published Work:

  Candidate has prepared the full draft of manuscript and supervisors' and coauthors' comments and input to the manuscript have been to the same extent as the usual thesis chapter supervision input.

Jackki Yim Digitally signed by Jackki Yim [illegible] Date: 2013.04.24 08:12:58 +12'00'

Candidate's Signature

24 April 2013

Date

Duncan Babbage, PhD
2013.04.24 08:03:07
+12'00'

Principal Supervisor's signature

24 April 2013

Date

GRS Version 3 – 16 September 2011

Chapter 10: Study Three

Investigating cognitive functioning associated with changes in treatment for facial affect recognition deficits following traumatic brain injury

Yim, J., Babbage, D. R., Zupan, B., Neumann, D., & Willer, B. (Manuscript being prepared for submission). Investigating cognitive functioning associated with changes in treatment for facial affect recognition deficits following traumatic brain injury.

Abstract

In a multicentre randomised controlled trial, we showed that targeted facial affect recognition treatment (*Faces*) can train people with moderate to severe TBI to be more effective in facial affect recognition. The current study explored the baseline cognitive variables, including other demographic characteristics associated with long-term treatment response and examined whether changes in cognitive functioning mediate the effects of *Faces* treatment in this clinical group. Forty-seven participants with TBI were randomly assigned to the *Faces* treatment or to a Control condition and completed pre- and post-treatment assessments of facial affect recognition and of a range of cognitive domains. The facial affect recognition measure was readministered after treatment (i.e., at six month follow-up). Only older age was found to predict a better long-term response to *Faces* treatment. The improvement of facial affect recognition was not mediated by changes in cognitive functioning, the latter being unassociated at baseline with long-term treatment response. The theoretical and clinical implications of these findings for the relationship between facial affect recognition impairments and cognitive deficits in TBI are discussed.

Investigating cognitive functioning associated with changes in treatment for facial affect recognition deficits following traumatic brain injury

Cognitive impairment is common after moderate to severe traumatic brain injury (Dikmen et al., 2009; Ruttan et al., 2008). A growing number of studies have now shown that many people with moderate to severe traumatic brain injury (TBI) have difficulty recognising facial cues of affect in others (D R Babbage et al., 2011; Bornhofen & McDonald, 2008a; Croker & McDonald, 2005; Knox & Douglas, 2009; Radice-Neumann et al., 2007; C. Williams & Wood, 2010). While recent research has demonstrated that a variety of targeted techniques can improve facial affect recognition in people with TBI (Bornhofen & McDonald, 2008b, 2008c; Guercio et al., 2004; Radice-Neumann et al., 2009), little is known about whether cognition changes with this improvement after treatment. To date, the baseline factors, including cognitive functioning, that are involved in predicting response to facial affect recognition training for this clinical group have yet to be fully determined. There is clearly a need to understand the mechanisms underlying emotion perception and the factors associated with success in responding to facial affect recognition training. For the purposes of this study, cognitive functioning refers to general cognitive abilities such as attention, working memory, language and executive functioning that do not involve any affective component.

Several clinical trials have examined the efficacy of training programmes designed to improve facial affect recognition skills for people with TBI (Bornhofen & McDonald, 2008b, 2008c; Guercio et al., 2004; Radice-Neumann et al., 2009). For instance, a randomised controlled study by Radice-Neumann et al. (2009) evaluated the effectiveness of two computer-based training programmes in improving facial affect recognition skills in adults with TBI. The programmes addressed two different aspects of emotion processing: one of them, *Faces*, focused on retraining people to identify emotions in others through analysing facial expressions (as conveyed through the eyes or mouth, for example); the other, *Stories*, focused on retraining people to infer emotions within social contexts. Nineteen participants with moderate to severe TBI were randomly assigned to training in either *Faces* or *Stories*. Both types of training consisted of six to nine sessions over a two-week period, each session lasting one hour.

The authors reported that the group trained in *Faces* not only improved in emotion recognition from faces but also extended this skill to social contexts and socio-emotional behaviours. In contrast, *Stories* training led only to improved ability in making emotional inference from social contexts. Other treatment studies using alternative cognitive training strategies such as errorless learning, positive reinforcement and self-monitoring have also successfully improved emotion perception capacities in patients with TBI (Bornhofen & McDonald, 2008b). However, a recent treatment study incorporating facial mimicry and focused attention in the training of facial recognition skills in adults with TBI failed to replicate such effects (McDonald et al., 2009b). The lack of treatment effects from this study might be attributed to the short duration of the training (a single session consisting of two different treatments, each for 20 minutes).

While the results from these initial treatment studies were generally encouraging, an important question that has yet to be fully investigated is the identification of the factors that may impinge on treatment response. A closer examination of the individual data in each study in the five initial trials indicates that there is variability in TBI patients' response to the facial affect recognition training programme. Some patients improved significantly, others less, and some remained unchanged. Of the ten participants in Bornhofen and McDonald's study (2008b), two patients with TBI showed significant improvement as measured by the Facial Affect Naming test scores after treatment; the others, on the other hand, showed little or no change. Radice-Neumann et al. (2007) reported that nine out of ten TBI patients benefited from the treatment but that one did not. One possible explanation for these findings is that treatment works well for some individuals with TBI but is not effective for others.

This outcome variability with respect to individual treatment response highlights a need to identify the factors that differentiate those individuals who show significant response to facial affect recognition training from those who exhibit minimal or no response. Studies of brain injury rehabilitation have consistently shown that baseline cognitive functioning is an important factor that predicts a positive response to cognitive rehabilitation (Dikmen et al., 2009). If, therefore, a person with TBI has impaired cognitive functioning, it is reasonable to assume that this impairment is likely to hinder that person's ability to benefit from facial affect recognition intervention, which requires at least some degree of attention, working memory, information processing speed and learning skills. These cognitive domains are often impaired in people who have suffered moderate to severe brain injury (Ruttan et al., 2008). To our knowledge, no studies have directly examined cognitive predictors of response to facial affect recognition training programmes in people with TBI, and particularly predictors of long-term response. Identification of the cognitive factors—as well as other baseline factors—involved in predicting response to affect recognition treatment could help us refine the treatments, and tailor interventions to the TBI patients most likely to benefit from them.

Another unexplored area in this domain is whether the improvement in emotion recognition skills after training was mediated by changes in cognitive functioning; and if so, the nature of the specific cognitive domains involved. Understanding this process is significant because people with TBI are frequently also suffering from cognitive impairments. As far as we are aware, most of the initial treatment studies merely assessed TBI patients' cognitive functioning at pre-test in order to determine their premorbid cognitive functioning. There is conflicting evidence from correlational studies in TBI (Allerdings & Alfano, 2006; Spikman et al., 2012; Tonks et al., 2008) and in other clinical disorders (Pinkham et al., 2003; Sachs et al., 2004; Shamay-Tsoory et al., 2007) as to whether the facial affect recognition and cognitive deficits are part of a common impairment or are a domain-specific deficit. Therefore, addressing this question could shed further light on the nature of facial affect recognition-cognition linkage. It could also facilitate the refinement of theoretical models underpinning facial affect recognition.

In this study, we sought to better understand the effects of cognitive functions on treatment outcomes and their trajectory after facial affect treatment in people with TBI. Specifically, our first aim was to determine whether baseline cognitive abilities were related to improvement in facial affect recognition at six-month post-training, and if so, which specific cognitive domains were most predictive of treatment response. In an exploratory analysis, other baseline factors such as age, education, gender, time since injury and types of injuries were also examined. Our second aim was to examine whether increased facial affect recognition skills after treatment were mediated by changes in cognitive functioning. Unlike previous studies using a mainly standard paper-and-pencil neuropsychological battery of tests and assessing limited cognitive domains, we used a computerised neuropsychological battery of tests—CogState

(Darby et al., 2002)—which assesses a wide range of cognitive domains. Importantly, the CogState has been shown to have acute sensitivity to cognitive change in patients presenting various clinical disorders, among them brain injury. Given the contradictory findings regarding the link between facial affect recognition and cognitive functioning, no hypotheses were made with regard to the role of cognitive functioning on treatment outcome.

Method

Participants

The data were drawn from a wider study comparing the efficacy of two new treatments (*Faces* and *Stories*) with an active sham treatment control to improve facial affect recognition in people with TBI. As our preliminary findings indicated that only *Faces* treatment was effective in retraining facial affect recognition capacity when compared to the control group (see Chapter Seven), this study analysed the data from those who had completed the *Faces* treatment and from participants in the control group. Participants were recruited from facilities providing brain injury rehabilitation services and support groups across three sites: St Catharines, Ontario, Canada; Charlotte, North Carolina, USA; and Wellington/Palmerston North, New Zealand. This study was approved by research ethics committees at all participating institutions. The participants were all willing to participate in the treatment trial and gave informed written consent to this effect.

The original sample from the wider study consisted of 70 participants with moderate to severe TBI who met the study's criteria and took part in the treatment trials. The inclusion criteria included people: (1) aged 18-65 years old; (2) who had sustained a moderate or severe TBI as determined by a Glasgow Coma Scale score of less than or equal to 12, or suffered post-traumatic amnesia or loss of consciousness of at least 24 hours; (3) who scored at least 1.5 standard deviations below age-group norm on the Diagnostic Assessment of Nonverbal Affect-2, Adult-Faces (Nowicki & Duke, 1994), a standardised assessment of facial affect recognition (to meet the criteria for the subsequent clinical trial, participants had to maintain a score of at least one standard deviation below the norm at pre-testing two weeks later); (4) who were at least one year post injury; (5) aged eight or older at the time of injury; and who (6) had scored at least 75% accuracy on the Discourse Comprehension Test (an asssessment for comprehension; Brookshire & Nicholas, 1993). Exclusion criteria included impaired vision or hearing, pre-injury major psychiatric history, and substance dependence. The 70 participants were randomised to one of the three nine-session treatment conditions: *Faces*, *Stories*, and Cognitive (control). All participants in the three conditions completed the full training programme.

Because the first focus of the current study was to assess the baseline predictors of long term treatment response, we limited the analyses to the 23 participants who completed the *Faces* treatment. The mean age of participants was 41.0 years (*SD* = 11.6) and they were on average 10.79 years post injury (*SD* = 10.2). The mean period of education was 12.30 years (*SD* = 1.68). Most had sustained severe TBI (n = 22 severe, n = 1 moderate). Data on post-traumatic amnesia were available for the majority (n = 22); all of these participants had had PTA lasting longer than seven days.

As the second focus of the present study was to evaluate whether increased facial affect recognition skills after treatment was mediated by changes in cognitive functioning, our analysis is restricted to participants who were administered the *Faces* and the *Cognitive* treatments (control condition), the final sample for the current study consisted of 47 participants (23 participants in the *Faces* group and 24 participants in the Control group). The mean age of participants was 41.0 years (*SD* = 11.6) and they were on average 10.5 years post injury (*SD* = 8.2 years). The mean period of education was 12.7 years (*SD* = 2.5). Most had sustained severe TBI (n = 45 severe, n = 2 moderate). Data on post-traumatic amnesia were available for the majority (n = 45); all of these participants had had PTA lasting longer than seven days.

Measures

Participants completed a range of tests assessing cognition, emotion recognition, community integration, interpersonal behaviour and empathy as part of the larger study of treatment effects. However, only test results relevant to this study are reported in this article.

Facial affect recognition

*The Diagnostic Analysis of Nonverbal Accuracy 2-Adult Fa*ces (DANVA2-Adult Faces; (Nowicki & Duke, 1994) assesses affect recognition from facial expressions. It consists of 24 photographs of faces that vary in gender, ethnicity, emotion and emotional intensity. Each photo was presented on a computer screen for 15 seconds, a variation from the standard procedure for this measure, as presentation is normally for two seconds. Presentation time was changed to minimise the effect of information processing speed and visuoperceptual abilities on performance. Thus, this was a conservative test of impairment since this may have increased scores for our participants relative to the norms. Participants were asked to choose one of four emotion labels—happy, sad, angry, fearful—listed below the picture to best describe how the person in the photograph was feeling. The DANVA2-Adult Faces has been reported to be a valid and reliable measure of emotion recognition (Nowicki, 2010). Test-retest reliability was .81 in a study with persons having TBI (Radice-Neumann et al., 2009; Spell & Frank, 2000). The DANVA2-Adult Faces was administered at screening, pre-test, post-test, and at the three- and six-month follow-ups. Administration of the DANVA2-Adult Faces twice before treatment (at screening and at pre-test) served two purposes: to establish baseline performance and to ensure we identified persons with brain injury who showed consistent difficulty in identifying facial emotional expression.

Cognitive assessment

The CogState test battery comprises a set of independent tasks that assess a range of cognitive abilities (Darby et al., 2002). For this study we used the seven tasks that evaluated domains of cognitive function known to be sensitive to cognitive changes following TBI. These tasks comprised indices of verbal learning (International Shopping List Task), verbal delayed memory (International Shopping List Task-Delayed Recall), speed of processing (Detection Task), attention/vigilance (Identification Task), visual working memory (One Back Task), non-verbal learning (Continuous Paired Association Learning Task) and executive functioning (Set-Shifting Task). The CogState battery is sensitive to mild cognitive impairments from a variety of causes including TBI (Darby et al., 2002; A. M. Douglas, Porter, Knight, & Maruff, 2011; Fredrickson et al., 2010; Maruff et al., 2009), and has minimal practice effects (Falleti et al., 2006). The validity and reliability of the battery has been established from over 100 peer-reviewed scientific articles (see *www.cogstate.com*). CogState subtests were administered at pre-test and post-test only.

Procedure

All assessment and treatment sessions were conducted in a quiet room in a university facility, a clinic, a rehabilitation service, or another suitable location. After completion of screening and baseline assessments, eligible participants were randomly allocated to either the *Faces* (Facial Affect Recognition) or the Cognitive control groups. All participants received nine one-hour treatment sessions, provided free, over a three-week period. Each participant was assessed five times in total: at initial screening, at pre-testing and post-treatment, and at the three-month and six-month follow-ups. Pre-test assessment was conducted within 15 to 28 days after the initial screening providing a second pre-treatment opportunity to confirm impaired facial affect recognition functioning while being a long enough interval to control for the most acute practice effects. (Any practice effects would also have served to improve performance, thus ejecting participants from trial eligibility). Participants were post-tested within four days of completion of all training sessions. Treatments were computer-based with one-on-one therapist involvement. Independent assessors, who were blind to the treatment assignment, examined the outcome assessments, and the order of the tests was counterbalanced. Each participant was paid a small amount per assessment session (and at some sites, also for treatment sessions) in partial recognition of travel expenses and effort—exact payment amounts varied across sites, associated with local budgets, ethical review board policies, and the geographical range potential participants might be travelling, but all were in the order of US$10–$15 per session.

Overview of Treatment

Faces intervention

Faces is a therapist-facilitated computerised training programme designed to improve facial affect recognition that was developed as part of the current wider research programme. It consists of seven training exercises that address two components, one teaching participants to attend to specific emotional facial features (facial-feature processing), the other focusing on development of emotional self-awareness (self-emotional processing). In the first component of the *Faces* training, participants were presented with 40 faces standardized by Gur et al. (2002) that displayed four core emotions (happy, sad, angry, fearful) that varied in terms of gender, emotional intensity and ethnicity. Participants viewed these faces on a computer screen and were taught by means of strategies such as repetition, vanishing cues, feedback and procedural learning, to concentrate on specific features of each face. For each face stimulus, participants had to identify the emotions conveyed. Additional requirements were gradually introduced, including discussion of personal emotion-laden events or imitation of the facial expressions. After completing the first component of the *Faces* training, the therapist chose for further discussion in the second component eight emotion-related events described by the participant. Each was now asked to recall and describe personal experiences that corresponded to specific emotions, and then to mimic that facial affect using a mirror. Participants were also required to describe the physical and physiological changes to the body they thought would be associated with each emotion (sadness, for example, is associated with heaviness in the chest, arms, and legs and with tightness in the throat and eyes). For each of the eight emotion-related events, participants were asked to describe the following: details of the event; what led up to it; how the event made them feel (the physical/physiological changes they felt at the time of the event were also elicited); why they felt the way they did; how they responded; and the consequences of the event and their response to it.

Control group

This control intervention focused on training cognitive skills (non-social), and simulations of skills for daily living which did not involve any emotional component. In order to ensure that the improvement in the treatment groups was due to the treatments and not merely to interpersonal interaction with the therapist, participants in the control group received a 'sham intervention' that provided sessions matched to the other two groups in number and duration, and matched in the amount of attention received from the therapist. In this control group, the participants engaged in a wide range of therapist-facilitated computerised cognitive exercises such as memory skills, maths skills, career skills and functional skills. These computerised training exercises were carefully selected from three internet sites to target various cognitive skills: GCF LearnFree.org (http://www.gcflearnfree.org), Cognitive Labs (http://cognitivelabs.com/gamelist.htm), and the Brain Ball (http://playwithyourmind.com/brain-games/wordball). The GCF LearnFree.org website offers many life skills activities for four major areas: everyday life; math and money; workplace and career; computer skills. The Cognitive Labs and the Brain Ball websites, on the other hand, provide various games and exercises presented as intending to improve cognition. Participants in the control did not know that they were part of the control intervention; they were under the impression that they were simply completing a different training regimen from the other treatment groups. Anecdotally, many participants in the control group were clearly energised and motivated for the treatment they were receiving, and reported it was benefitting them—suggesting a robust treatment control had been created.

Missing Data

For the DANVA2-Adult Faces measure, the missing data ranged from 7.4% to 21% for the three post-treatment assessments. The data missing were attributable mainly to a failure to complete the follow-up assessments after training. With the exception of the executive function domain, data missing in each of the cognitive domains were less than 4% at pre-test and between 28% and 31% at post-test. The primary reason for this missing data was participant refusal to complete the task, citing task difficulty. For the executive function domain, the incidence of missing data was higher: 30% for the pre-test and 65% for the post-test. In all cases, the missing data resulted from software problems in recoding participant responses with the (recently developed) set-shifting subtest. As such these missing data were likely to be missing at random and would not therefore create a biased sample. For the missing data, Rubin’s multiple imputation function was used to estimate the missing cognitive values and SPSS default setting of five imputations was employed. The pooled estimates of the multiple imputed values were used in all analyses. As SPSS reports pooled results for only a limited range of analyses, for analyses without the pooled estimates, the average from the five datasets was provided.

Data Analysis

Raw DANVA2-Adult Faces raw scores were converted to z-scores using normative data from the test manual. On the other hand, the raw scores for each of the seven cognitive tasks were converted to z-scores using the sample means and standard deviations. A composite cognitive score (or overall cognitive functioning) was then calculated by averaging all z-scores for these seven cognitive tasks (according to the guidelines from the Cogstate manual). The advantages of using a composite score is that they could increase power by reducing random variability, floor and ceiling effects, and the number of correlated data in analysis (Schneider et al., 2007). As the SECT did not involve solely cognitive functioning, this cognitive domain of the CogState was removed from the analyses because we wanted to examine the relationship between cognitive functioning (non-affective processes) and facial affect recognition (affective processes).

We first examined the data to check for outliers and to determine the data distribution. To determine whether baseline cognitive abilities and other demographic characteristics were related to improvement in facial affect recognition at six-month post-training, participants in the *Faces* treatment were dichotomised into treatment responders and non-responders using the DANVA2-Adult Faces scores at six month follow-up. (It was observed that the DANVA2-Adult Faces scores had a moderately bimodal distribution). The rationale for the dichotomisation of the DANVA2-Adult Faces scores was that we believed group means would provide a more intuitive description of magnitude of change than would simple correlation of baseline variables with change DANVA2-Adult Faces scores in the *Faces* group. Other merits of dichotomising include easy interpretation and presentation of results as a result of the statistical analysis being simplified. It is acknowledged, however, that dichotomising may reduce statistical power. Treatment responders were determined using the following criteria: participants demonstrating a DANVA2-Adult Faces z-score in the range - 1.0 or higher at six month follow-up (i.e. towards the positive range that could be considered to be in the broadly normal range) and a z-score change of 1.0 or greater from the baseline to six month follow-up (i.e. in the direction of improvement that could be considered to be a significant change). In order for a participant to be a treatment responder, both of these requirements would need to be true. This is because if they baseline score was fairly close to the z-score = -1.0 cut-off already, then the six-month follow-up would need to be higher so that they still met the second criterion. The non-responders were those who did not meet those criteria. A series of independent t-tests was used to determine if there were significant differences between the treatment responders and non-responders on any of the baseline cognitive variables and other demographic variables.

To examine the study's second aim, Pearson correlations were planned to examine the relationship between changes in both individual and composite z-scores for cognitive variables and the change of score for DANVA2-Adult Faces. The same analyses were carried out, using this time the treatment group. For the cognitive and facial affect recognition measures, the change of z-scores was calculated by subtracting the pre-test z-score from the post-test z-scores. If the above correlation analyses produced significant results, regression tests would then be used to further test the mediating role of cognitive variables in accordance with the procedures described by Baron and Kenny (1986).

All data were analysed using SPSS version 20. The statistical significance alpha value was set at 0.05. Because of the exploratory nature of this study, where Type II errors were considered as harmful as Type I errors, we did not make Bonferroni corrections for multiple comparisons, and rather intended to critically examine effect sizes and plan for future replication of any significant results.

Results

Comparison between Treatment Responders and Non-responders

We first analysed the data for the 23 participants who had completed the Faces treatment. These participants were grouped into treatment responders and non-responders. Table 10 shows the baseline demographic and clinical characteristics of the treatment responders and non-responders.

Table 10

Demographic and Clinical Characteristics of Treatment Responders and Non-responders to the Faces Treatment

	Treatment responders Mean (SD)	Non-responders Mean (SD)
Number of participants	9	14
Age	48.86 (9.97)	38.27 (10.07)
Gender	9 males	14 males/ 1 female
Education in years	13.05 (.26)	11.74 (.77)
Time since injury	12.66 (12.79)	9.71 (8.6)
PTA	3 (.27)	2.93 (.12)
DANVA2-Adult Faces (at baseline)	13.46 (1.65)	13.29 (2.77)

Note. DANVA2-Adult Faces = Diagnostic Analysis of Nonverbal Accuracy 2-Adult Faces.

There was no significant difference between responders and non-responders in any of the baseline cognitive domains: nonverbal learning, $t(18) = 1.08$, $p = .28$; working memory, $t(18) = .81$, $p = .42$; attention, $t(18) = .87$, $p = .39$; executive functioning, $t(18) = .56$, $p = .58$; speed of processing, $t(18) = 1.69$, $p = .09$; verbal learning, $t(18) = .93$, $p = .35$; verbal delayed memory, $t(18) = .84$, $p = .40$. In terms of demographic variables, there was a significant difference in the mean age between treatment responders (*M* = 48.86, *SD* = 8.6) and non-responders (*M* = 36.27, *SD* = 14.4)—responders were older, *t*(21) = 2.75, p = .006. Treatment responders did not significantly differ in level of education (*M* = 13.05, *SD* = 8.6) from non-responders (*M* = 11.74, *SD* = 11.4), *t*(18) = 1.815, *p* = .07. Treatment responders and non-responders also were not significantly different in gender, X^2 = .56, *p* = .46, ethnicity, X^2 = 1.84, *p* = .18, types of injuries, X^2 = 4.79, *p* = .19, and time since injury, *t*(21) = .64, *p* = .52.

Cognition Function as a Possible Mediator

We then analysed the data for the 47 participants who had completed the *Faces* and the Cognitive treatments (control group). Preliminary Pearson correlation analyses revealed no statistically significant correlations between the change z-scores in any of the cognitive measures (working memory, attention, executive functioning, information processing speed, verbal memory and delayed verbal memory) and the DANVA2-Adult Faces change z-scores at post-test. Similarly, we did not find any significant relationship between the composite change z-score for the cognitive function tests and change of DANVA2-Adult Faces z-score from baseline to post-test; nor were there significant associations between the treatment groups (*Faces*, control) and change in z-scores in any of the cognitive domains except information processing speed. No correlation between the treatment groups and the change in composite cognitive z-score was observed. A summary of the correlation coefficients between the changes in performance on cognitive function tests and changes in facial affect recognition scores and treatment group is presented in Table 11. Given the above findings, we did not conduct further analyses for the mediation effects as the conditions for mediation were not met. These data suggest that cognitive functioning may not mediate the effects of treatment on facial affect recognition performance.

Table 11

Correlation between Cognitive Function and Facial Affect Recognition Z-Score Changes and Treatment Group from Baseline to Post-Treatment

	DANVA2-Adult Faces Δ	Treatment group
Cognitive domain	*r*	*r*
Non-verbal memory Δ	.038	.035
Working memory Δ	.161	.116
Attention Δ	.180	.063
Executive functioning Δ	.021	.053
Speed of processing Δ	.003	.361*
Verbal memory Δ	.016	.045
Verbal delayed memory Δ	.002	.074
Composite cognitive score Δ	.184	.170

* $p < .05$

Discussion

Two major issues were addressed in the current study. First, we assessed the cognitive domains and other baseline factors that can longitudinally predict response to facial affect recognition treatment. We found that none of the baseline cognitive variables differed significantly between the treatment responders and non-responders (although these null results may have occurred because of low statistical power). When other baseline demographic and clinical characteristics were compared, only participants' age was predictive of better treatment response at six month follow-up. These results remained when time of injury was controlled in the analysis. Specifically, our results showed that treatment responders were older than non-responders. It is not clear, however, why older participants appeared more responsive to the *Faces* treatment than younger participants. The overall social cognitive repertoires of the older participants before brain injury were in all likelihood greater because they had had more opportunities for social engagement, interactions and emotional experiences. This heightened repertoire at pre-treatment may have facilitated their positive treatment response by inducing their experiential understanding of other people's emotions and perhaps their own emotions through compensatory mechanisms of some kind. Differences in level of motivation may also play a role in this. Future research should investigate this area more thoroughly.

Our second goal was to investigate whether changes in cognitive functions were the mediator for the improvement of facial affect recognition ability after *Faces* treatment. Our investigation showed that increase in facial affect ability was not attributable to changes in other aspects of cognitive functioning, suggesting that the changes in facial affect recognition may be due to changes in this specific domain. Our results are in line with a recent study by Horan et al. (2009) that investigated the efficacy of a new social cognition training programme designed to enhance several aspects of social cognition (facial affect recognition, social perception, attributional style, Theory of Mind) in a group of 34 outpatients with psychotic disorders. In that study, the patients of the training group showed significant improvement in facial affect recognition; and these improvements were found to be independent of changes in cognitive performance. Evidence supporting the dissociation of emotion recognition and cognitive functions also comes from neuroimaging studies, which demonstrated a specific network of brain regions underlying emotional processing (see review by Adolphs, 2002). It seems that our *Faces* treatment may have explicitly targeted the facial affect recognition domain, thereby enhancing the emotion recognition skills of participants with TBI but not their cognitive functioning. The precise components of the *Faces* treatment that contributed to this improvement are, however, unclear at this stage and require further investigation.

These findings contribute to the theoretical debate concerning the nature of facial affect recognition impairments, and in particular its relationship with cognitive functioning. Evidence from a few correlation studies that have directly examined the associations between the two domains in the TBI population is mixed. Some researchers have demonstrated that facial affect recognition deficits were not correlated with cognitive functioning (Spikman et al., 2012; Tonks et al., 2008), while others showed the opposite pattern (Allerdings & Alfano, 2006). Spikman et al. (2012), for instance, observed that a wide range of social cognition measures (emotion recognition, theory of mind, and empathy) in a group of 28 adults with moderate to severe TBI were not related to particular general cognitive functions such as memory, mental speed, attention and executive functioning. In contrast, tentative data from our recent work has suggested that facial affect recognition deficits after TBI are related most closely to nonverbal learning, working memory and speed of processing impairments (Yim, Babbage, Zupan, Neumann, & Willer, accepted pending minor revision). The results from our present study indicate that facial affect recognition may be a discrete skill and changes in facial affect functioning may not be associated with or mediated by other domains of cognitive functioning. This finding stands alongside previous correlation studies (including our own analysis of data from this wider research programme) which have found an association between the degree of acquired impairment in facial affect recognition and impairment in other cognitive domains. (Allerdings & Alfano, 2006; Yim et al., accepted pending minor revision).

These two things are not mutually exclusive. Specific mechanisms of injury or injury to specific brain locations may affect multiple cognitive functions localised in those areas or more susceptible to damage to interconnections between functional areas. Another possible explanation is to think of emotion perception, as suggested by Mathersul et al. (2009), as comprising two components: the more spontaneous, automated, implicit operation of decoding facial expressions (less dependent on cognitive resources), and the more effortful, controlled, cognitively demanding process that enables us to make explicit facial affect recognition inferences. Extrapolating from this model, it may be that for some individuals with TBI, identification of facial emotional expressions is based more on the implicit route, whereas for others it is perhaps based more on the explicit route (conceivably as a result of impoverished implicit capacity and/or task difficulty). In the latter case, we speculate that significant cognitive effort would be required to aid with the facial affect recognition tasks, and that the correlation between facial affect recognition impairments and cognitive functions would therefore be stronger. It may even be that the interface between facial affect recognition impairments and cognitive functions becomes diluted when the modification of the brain regions associated with emotion recognition occurs as a result of the emotion recognition treatment. Such interpretations could—at least partially—explain the divergent findings in past studies with regard to the links between facial affect recognition deficits and cognitive impairments among people with TBI. An interesting area for future research would be to test whether increases in facial affect recognition abilities through rehabilitation treatment would result in refinement of the implicit capacity to scaffold emotional facial information.

The present study has several limitations. Firstly, the sample size was relatively small—albeit falling on the larger size of average for intervention studies in neurorehabilitation; see the average size of studies referenced in Cicerone et al. (2011). Statistical power may therefore be underpowered for detection of subtle mediation effects and/or differences—an ongoing problem across neurorehabilitation and neuroscience research (Button et al., 2013). Replication of this research in larger samples is clearly needed. Secondly, while imputation was used for missing data, the reliability of the imputed datasets may be compromised when more than 30% of scores are missing. Thus, the lack of association between cognitive functioning and treatment response and outcome after the affect recognition training could partly be due to this methodological problem (for example, it could reduce variation of scores and therefore reduce associations measured). Thirdly, the correlation analyses between changes in facial affect recognition and cognitive functions were based on one time point (immediately following treatment). We did not collect follow-up data relating to the changes in cognitive functioning, so the longer-term influence of cognitive functioning on changes in facial affect recognition is unknown. Fourthly, we did not address factors such as level of motivation, cultural and social experiences, and type of learning style, all of which could have influenced patients' responses to our intervention. Motivation, for example, has been shown to be a crucial factor in interventions for cognition for people with brain injury (Crowe, 2008). Finally, we did not control for the influence of medication on cognitive performance, although the heterogeneous set of medication regimens precluded us from establishing which medication regime contributed most to cognitive performance.

The findings from the present study have both theoretical and clinical implications. The current findings speak to the complex association between impaired facial affect recognition and cognitive dysfunction, suggesting that variations in facial affect recognition impairment after TBI may strengthen or weaken the degree of cognitive functioning involvement. This highlights the need for researchers to develop better and more sensitive measures for facial affect recognition. It would be pertinent, furthermore, for clinicians to assess the strengths and weaknesses in different facial affect recognition capacities of people with TBI. Given that age may have considerable influence on treatment responses, facial affect recognition treatments could be developed to suit patients with TBI of particular age groups. The treatment, for example, may be altered to include opportunities for younger patients with brain injury to experience and engage actively in social-based activities so that their overall social cognitive functioning, facial affect recognition capacities included, could be enhanced. Focusing their sense of expectancy for the treatment might also be helpful in maintaining their engagement in it.

To further elucidate the mechanisms underlying facial affect recognition impairments after brain injury and the precise connection with other domains of cognitive functioning, future studies should incorporate neuroimaging techniques and physiological measures. Different measures assessing various aspects of facial affect processing and measures assessing a broad range of cognitive functions should also be included. The relative demands placed on cognitive resources by different facial affect recognition processes require further study. Future research could also examine the mechanisms of change underlying facial affect recognition treatments for people with TBI. There is also a need to further understand the predictors of treatment response to facial affect recognition treatment for this clinical group. Such research will likely inform the development of interventions optimising treatment outcomes in people with TBI who are suffering from facial affect recognition impairment.

In conclusion, this study suggests that the improvements in facial affect recognition abilities following *Faces* treatment are not necessarily dependent on cognitive functions, although they may be closely connected. There seems little doubt that the relationship between facial affect recognition impairments and cognitive dysfunction in TBI will be complex and multifactorial, and may be partly influenced by target of intervention, individual differences in facial affect recognition impairments and processing style. Our study also suggests that the facial affect recognition deficits of people with TBI can be augmented by using targeted facial affect recognition interventions, and that nd age may influence treatment response. More studies are needed to consider the interaction between individual factors to accurately predict treatment outcome. Understanding the true nature of facial affect recognition impairments in TBI and whether cognitive functioning is in fact not a contributory factor for the improvement of emotion recognition requires a large TBI sample, longitudinal studies, and a multi-method approach within a multidisciplinary perspective.

References

Adolphs, R. (2002). Recognizing emotion from facial expressions: psychological and neurological mechanisms. *Behavioral and Cognitive Neuroscience Reviews, 1*, 21-61.

Allerdings, M. D., & Alfano, D. P. (2006). Neuropsychological correlates of impaired emotion recognition following traumatic brain injury. *Brain and Cognition, 60*, 193-194.

Babbage, D. R., Yim, J., Zupan, B., Neumann, D., Tomita, M. R., & Willer, B. (2011). Meta-analysis of facial affect recognition difficulties after traumatic brain injury. *Neuropsychology, 25*, 277-285.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistically considerations. *Journal of Personality and Social Psychology, 51*, 1173-1182.

Bornhofen, C., & McDonald, S. (2008a). Emotion perception deficits following traumatic brain injury: A review of the evidence and rationale for intervention. *Journal of the International Neuropsychological Society, 14*, 511-525.

Bornhofen, C., & McDonald, S. (2008b). Treating deficits in emotion perception following traumatic brain injury. *Neuropsychological Rehabilitation, 18*, 22-44.

Bornhofen, C., & McDonald, S. (2008c). Comparing strategies for treating emotion perception deficits in traumatic brain injury. *Journal of Head Trauma Rehabilitation, 23*, 103-115.

Button, K. S., Ioannidis, J. P., Mokrysz, C., Nosek, B. A., Flint, J., Robinson, E. S., & Munafò, M. R. (2013). Power failure: why small sample size undermines the reliability of neuroscience. *Nature Reviews Neuroscience*.

Cicerone, K. D., Langenbahn, D. M., Braden, C., Malec, J. F., Kalmar, K., Fraas, M., . . . Ashman, T. (2011). Evidence-based cognitive rehabilitation: updated review of the literature from 2003 through 2008. *Archives of Physical Medicine and Rehabilitation, 92*, 519-530.

Croker, V., & McDonald, S. (2005). Recognition of emotion from facial expression following traumatic brain injury. *Brain Injury, 19*, 787-799.

Crowe, S. F. (2008). *The behavioural and emotional complications of traumatic brain injury*. New York: Taylor & Francis Group.

Darby, D., Maruff, P., Collie, A., & McStephen, M. (2002). Mild cognitive impairment can be detected by multiple assessments in a single day. *Neurology, 59*, 1042-1046.

Dikmen, S. S., Corrigan, J. D., Levin, H. S., Machamer, J., Stiers, W., & Weisskopf, M. G. (2009). Cognitive outcome following traumatic brain injury. *Journal of Head Trauma Rehabilitation, 24*, 430-438.

Douglas, A. M., Porter, R. J., Knight, R. G., & Maruff, P. (2011). Neuropsychological change and treatment response in severe depression. *The British Journal of Psychiatry, 198*, 115-122.

Falleti, M. G., Maruff, P., Collie, A., & Darby, D. G. (2006). Practice effects associated with the repeated assessment of cognitive function using the CogState battery at 10-minute, one week and one month test-retest intervals. *Journal of Clinical and Experimental Neuropsychology, 28*, 1095-1112.

Fredrickson, J., Maruff, P., Woodward, M., Moore, L., Fredrickson, A., Sach, J., & Darby, D. (2010). Evaluation of the usability of a brief computerized cognitive screening test in older people for epidemiological studies. *Neuepidemiology, 34*, 65-75.

Guercio, J. M., Podolska-Schroeder, H., & Rehfeldt, R. A. (2004). Using stimulus equivalence technology to teach emotion recognition to adults with acquired brain injury. *Brain Injury, 18*, 593-601.

Gur, R. C., Sara, R., Hagendoorn, M., Marom, O., Hughett, P., Macy, L., . . . Gur, R. E. (2002). A method for obtaining 3-dimensional facial expressions and its standardization for use in neurocognitive studies. *Journal of Neuroscience Methods, 115*, 137-143.

Horan, W. P., Kern, R. S., Shokat-Fadai, K., Sergi, M. J., Wynn, J. K., & Green, M. F. (2009). Social cognitive skills training in schizoprenia: An initial efficacy study of stabilized outpatients. *Schizophrenia Research, 107*, 47-54.

Knox, L., & Douglas, J. (2009). Long-term ability to interpret facial expression after traumatic brain injury and its relation to social integration. *Brain and Cognition, 69*, 442-449.

Maruff, P., Thomas, E., Cysique, L., Brew, B., Collie, A., Snyder, P., & Pietrzak, R. H. (2009). Validity of the CogState brief battery: relationship to standardized tests and sensitivity to cognitive impairment in mild traumatic brain injury, schizophrenia and aids dementia complex. *Archives of Clinical Neuropsychology, 24*, 165-178.

Mathersul, D., Palmer, D. M., Gur, R. C., Gur, R. E., Cooper, N., Gordon, E., & Williams, L. M. (2009). Explicit identification and implicit recognition of facial emotions: II. Core domains and relationships with general cognition. *Journal of Clinical and Experimental Neuropsychology, 31*, 278-291.

McDonald, S., Bornhofen, C., & Hunt, C. (2009). Addressing deficits in emotion recognition after severe traumatic brain injury: the role of focused attention and mimicry. *Neuropsychological Rehabilitation, 19*, 321-339.

Nowicki, S. (2010). *Manual for the receptive tests of the Diagnostic Analysis of Nonverbal Accuracy 2*. (Unpublished manuscript). Department of Psychology, Emory University, Atlanta, GA.

Nowicki, S., & Duke, M. (1994). Individual differences in the nonverbal communication of affect: the diagnostic analysis of nonverbal accuracy scale. *Journal of Nonverbal Behavior, 18*, 9-35.

Pinkham, A. E., Penn, D. L., Perkins, D. O., & Lieberman, J. (2003). Implications for the neural basis of social cognition for the study of schizophrenia. *The American Journal of Psychiatry, 160*, 815-824.

Radice-Neumann, D., Zupan, B., Babbage, D. R., & Willer, B. (2007). Overview of impaired facial affect recognition in persons with traumatic brain injury. *Brain Injury, 21*, 807-816.

Radice-Neumann, D., Zupan, B., Tomita, M., & Willer, B. (2009). Training emotional processing in persons with brain injury. *Journal of Head Trauma Rehabilitation, 24*, 313-323.

Ruttan, L., Martin, K., Liu, A., Colella, B., & Green, R. E. (2008). Long-term cognitive outcome in moderate to severe traumatic brain injury: a meta-analysis examining timed and untimed tests at 1 and 4.5 or more years after injury. *Archives of Physical Medicine and Rehabilitation, 89*, S69-S76.

Sachs, G., Steger-Wuchse, D., Kryspin-Exner, I., Gur, R. C., & Katschnig, H. (2004). Facial recognition deficits and cognition in schizophrenia. *Schizophrenia Research, 68*, 27-35.

Shamay-Tsoory, S. G., Shur, S., Barcai-Goodman, L., Medlovich, S., Harari, H., & Levkovitz, Y. (2007). Dissociation of cognitive from affective components of theory of mind in schizophrenia. *Psychiatry Research, 149*, 11-23.

Spell, L. A., & Frank, E. (2000). Recognition of nonverbal communication of affect following traumatic brain injury. *Journal of Nonverbal Behavior, 24*, 285-300.

Spikman, J. M., Timmerman, M. E., Milders, M. V., Veenstra, W. S., & van der Naalt, J. (2012). Social cognition impairments in relation to general cognitive deficits, injury severity and prefrontal lesions in traumatic brain injury patients. *Journal of Neurotrauma, 20*, 101-111.

Tonks, J., Williams, H. W., Frampton, I., Yates, P., Wall, S. E., & Slater, A. (2008). Reading emotions after childhood brain injury: case series evidence of dissociation between cognitive abilities and emotional expression processing skills. *Brain Injury, 22*, 325-332.

Williams, C., & Wood, R. L. (2010). Impairment in the recognition of emotion across different media following traumatic brain injury. *Journal of Clinical and Experimental Neuropsychology, 32*, 113-122.

Yim, J., Babbage, D. R., Zupan, B., Neumann, D., & Willer, B. (accepted pending minor revision). The relationship between facial affect recogntion and cognitive functioing after traumatic brain injury. *Brain Injury*.

DRC 16

MASSEY UNIVERSITY
GRADUATE RESEARCH SCHOOL

STATEMENT OF CONTRIBUTION
TO DOCTORAL THESIS CONTAINING PUBLICATIONS

(To appear at the end of each thesis chapter/section/appendix submitted as an article/paper or collected as an appendix at the end of the thesis)

We, the candidate and the candidate's Principal Supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the candidate's contribution as indicated below in the *Statement of Originality*.

Name of Candidate: Jackki Yim Hoon Eng

Name/Title of Principal Supervisor: Dr Duncan Babbage

Name of Published Research Output and full reference:

Yim, J., Babbage, D. R., Zupan, B., Neumann, D., & Willer, B. (Manuscript being prepared for submission). Investigating cognitive functioning associated with changes in treatment for facial affect recognition deficits following traumatic brain injury.

In which Chapter is the Published Work: Chapter Ten

Please indicate either:

- The percentage of the Published Work that was contributed by the candidate:

  and / or

- Describe the contribution that the candidate has made to the Published Work:

  Candidate has prepared the full draft of manuscript and supervisors' and coauthors' comments and input to the manuscript have been to the same extent as the usual thesis chapter supervision input.

Jackki Yim Digitally signed by Jackki Yim

Candidate's Signature

25 April 2013

Date

Duncan Babbage, PhD
2013.04.27 08:27:49
+12'00'

Principal Supervisor's signature

27 April 2013

Date

GRS Version 3 – 16 September 2011

Chapter 11: Overall Discussion and Conclusion

There is clear consensus that people with moderate to severe TBI have marked deficits in facial affect recognition (D R Babbage et al., 2011; McDonald, 2013; Radice-Neumann et al., 2007). These deficits may underlie some problems in social functioning (Knox & Douglas, 2009; Watts & Douglas, 2006). Several interventions have focused on enhancing emotion recognition skills in people with traumatic brain injury (Bornhofen & McDonald, 2008b, 2008c; Guercio et al., 2004; McDonald, Bornhofen, & Hunt, 2009a; Radice-Neumann et al., 2009). However, the evidence for the effectiveness of these interventions is unclear. Although the cognitive deficits in TBI are well-documented (Dikmen et al., 2009), little is known about whether broader cognitive deficits underlie facial affect recognition impairment. Less is known about baseline cognitive variables that predict treatment response and the relationship between changes in cognitive functioning and improvement in facial affect recognition after treatment. The present research formed part of a multi-centre randomised controlled trial, examining the efficacy of two affect recognition training programmes designed to improve emotion recognition in adults with moderate to severe TBI.

This section returns to the research aims to summarise the major themes that have arisen from this research and the contribution that the thesis has made to the literature on emotion recognition associated with TBI. The implications of the research are then considered, and suggestions made for further studies.

Research Aims

1. *To determine the efficacy of the two new affect recognition treatments (Faces and Stories) for people with TBI and their durability and effects on social functioning.*

Study One indicated that *Faces* treatment was effective in improving facial affect recognition in people with TBI and that these training gains were maintained at six-month follow-up. *Stories* treatment did not lead to an improved ability to infer the emotions of others from context. No significant differences between the treatment groups and the control group were found for interpersonal and social functioning measures.

2. *To investigate the relationships between facial affect recognition and cognitive functioning after TBI.*

Study Two demonstrated that greater facial affect recognition deficiencies were related particularly to working memory, processing speed, and non-verbal memory. No relationship was found with executive functioning.

3. *To explore the baseline cognitive variables and other demographic variables associated with long-term treatment response and to determine whether changes in facial affect recognition were mediated by cognitive functioning.*

Study Three showed that a more advanced age was predictive of better long-term response to *Faces* treatment. Improvement of facial affect recognition was not mediated by changes in cognitive functioning.

Contributions to the Literature on Emotion Recognition Associated with TBI

This current research makes important contributions to three lines of investigation: (a) the trainability of facial affect recognition in TBI and its durability; (b) the relationship between facial affect recognition and cognitive functioning; and (c) the processes involved in facial affect recognition changes. I discuss each of these three contributions below.

Consistent with previous research on rehabilitation of emotion recognition in TBI (Bornhofen & McDonald, 2008b, 2008c; Guercio et al., 2004; Radice-Neumann et al., 2009), Study One suggests that retraining is possible for affect recognition difficulties after traumatic brain injury through targeted emotion recognition training intervention. Using a randomised controlled trial with reasonably large sample sizes and comprehensive outcome measures, Study One provided stronger support of *Faces* treatment as a possible effective rehabilitation tool in enhancing affect recognition skills in people with TBI. In addition, it provides the first evidence that *Faces* treatment may produce enduring effects. The *Faces* treatment may have facilitated effective processing of facial emotional cues because the treatment focuses on internal emotional experiences and also involves close attention to external key features of faces expressing emotion. Current theoretical models of facial affect recognition have consistently cited both of these domains as instrumental for facial affect recognition accuracy (Adolphs, 2002; Decety, 2011; Eisenbarth & Alpers, 2011; Goldman & Sripada, 2005; Haxby et al., 2000; Oberman et al., 2007).

Through the findings of Study One, this research highlights the importance of continuing to develop effective training programmes to enhance facial affect recognition skills for people with TBI. The research identified some key processes that *Faces* treatment may contribute to the improvements of facial affect recognition and further highlights the need to understand the mechanisms underpinning the efficacy of emotion recognition training programmes, and their underlying theoretical models of emotion perception. It also demonstrates the importance of developing interventions that target specific facets of emotion recognition and utilize outcome measures that are clinically relevant to a given facet. This research points out that changing facial affect recognition, however important it is in itself, may be insufficient in isolation to enhance real-life social outcomes in people with TBI. There is therefore a strong need for continued efforts to understand the nature of facial affect difficulties in TBI and the ways such difficulties and other factors interrelate in contributing to poor social outcomes in people thus affected.

In addition to the question of efficacy, it is pivotal to understand the influence of cognitive functioning on facial affect recognition, given that cognitive impairments are prevalent after brain injury. Study Two is one of the few that directly examines the relationship between facial affect recognition and cognitive functioning after traumatic brain injury. Current evidence regarding the link between the two domains is limited and inconclusive, and most of the studies have been hampered by small sample sizes and limited outcome measures. Study Two has addressed these limitations by using a larger sample size and multiple facial affect recognition measures. In so doing, this study indicates that deficits in several cognitive processes are correlated with facial affect recognition deficits in TBI, particularly non-verbal memory, working memory and speed of processing. Also, this study identified that executive functioning may not be a critical cognitive factor in facial affect recognition, though in all likelihood may be important in deciding what to do once facial affect is perceived. Through these findings, new research questions are raised about how different cognitive deficits, combined or in isolation, may contribute to poor facial affect recognition performance, and how the makeup of emotional stimuli and task complexity of facial affect tasks may influence the emotion recognition-cognition links observed.

The third study is the first investigation that has been undertaken to explore the baseline cognitive variables and other demographic characteristics involved in predicting long-term treatment response to facial affect recognition training interventions. It also investigated whether increased facial affect recognition skills after treatment were mediated by changes in cognitive function. This is an important issue to address, given that cognitive dysfunction has been demonstrated to impede treatment outcome in other domains. While a computerised neuropsychological battery of tests that has been shown to be acutely sensitive to cognitive changes did not predict response to treatment, this study found greater age to be a predictor of better long-term responses to *Faces* treatment. While this may seem initially puzzling, it raises the possibility of a social cognitive repertoire or reserve, prior to injury, that may be a critical factor in facilitating positive treatment response through compensatory mechanisms of some kind. Differences in level of motivation may also play a role in this. Study Three also shows that improvements in facial affect recognition abilities following *Faces* treatment are not necessarily dependent on changes in cognitive functions, although they may be closely connected. The findings from Studies Two and Three at the very least, illustrate that the relationship between facial affect recognition impairments and cognitive dysfunction in TBI is complex and multifactorial.

Implications

The implications of each of the three studies that comprise this research were discussed in detail in their own chapters. The following section considers only the broader implications of this thesis. Taken together, findings from this research have both theoretical and clinical implications. The conflicting pattern of results from the present research, when compared to findings from previous research, indicates that facial affect recognition cannot be viewed simply as either a domain-specific deficit or as part of a broader cognitive dysfunction. Instead, affect recognition impairments appear multifactorial, in which the relationship with cognitive dysfunction may be decoupled or connected depending on the target of intervention, individual differences in the nature of facial affect recognition impairments, and processing style. Longitudinal studies using a sophisticated approach would be valuable for mapping the trajectories of affect recognition processing and cognitive functioning after brain injury, and after treatment of affect recognition difficulties.

The improvement resulting from the *Faces* treatment provides at least support for the perception, simulation, and conceptual knowledge theoretical models of emotion recognition (Adolphs, 2002, 2010; Decety, 2011; Eisenbarth & Alpers, 2011; Goldman & Sripada, 2005). According to these theories, recognizing an emotion from facial expression will require a person to perceive visual features of the face stimuli, to retrieve knowledge regarding a certain facial configuration with certain emotions, and to simulate the emotional state depicted by the target faces. This finding raises a theoretical question as to whether after TBI, an impairment in accessing stored knowledge, reduced capacity to simulate or atypical perceptual processing, or all of the three, contribute to facial affect recognition difficulties. Future research could usefully examine these questions.

The lack of significant improvement in the ability to make emotional inference from social context as measured by the Emotional Inference from Stories Test after the *Stories* treatment raises the question as to whether this treatment has specifically targeted theory of mind abilities. As the *Stories* treatment involves the participant reasoning about/inferring affective states, including the desires and behaviours of story characters in different social contexts (e.g., what a character thinks about another person's feelings) through social stories, it is likely that such processing could place a heavy demand on cognitive resources such as language and executive functioning. This may therefore have impeded participants' ability to fully benefit from the *Stories* treatment, more so in the case of those with reduced cognitive functioning capacity. It may even be the case that the Emotional Inference from Stories Test may not be sufficiently sensitive to detect improved emotional inference performance in the *Stories* group. This will be a worthwhile area for future researchers to investigate.

In terms of clinical implications, it is recommended that clinical assessments include measures that evaluate different aspects of affect recognition abilities alongside traditional neuropsychological measures. There is also a pressing need to develop effective intervention strategies to improve functional affect recognition for people with TBI. This may involve tailoring the affect recognition intervention to each individual's level of cognitive functioning (e.g., reducing working memory load) and developmental age, so as to maximise his/her ability to benefit from the training. This research suggests that *Faces* treatment may be a potential rehabilitative tool for people with TBI in augmentation of affect recognition skills. This treatment can be easily incorporated into the clinical setting, as it is brief and structured. The next step forward would be translational research examining whether the gains observed in the current research are found when the treatment is used in frontline settings, and also whether the intervention can be integrated with other skills training to lead to functional gains in social functioning. Given that there may be variations in terms of the overall social cognitive abilities and level of motivation among people with TBI, understanding an individual's social and emotional experiences, interest, and a sense of expectancy could also be a useful mechanism to enhance motivation and participation in the treatments.

Limitations

As the limitations and future directions offered by the three studies that comprise this research have also been discussed in previous sections, the following section considers the broader limitations of this thesis, in the context of limitations of all research conducted in this area to date, and the future directions these may suggest. Firstly, treatment studies evaluating the effects of emotion recognition training interventions in TBI vary considerably in terms of their design, the characteristics of study participants (e.g., age, and severity of deficits), lesion characteristics (e.g., time since injury, and injury severity) and the use of various emotion recognition measures. All of these make it difficult to draw clear comparisons between studies regarding the effectiveness of individual approaches to treatment. Comparisons across studies have been further limited by variations in training programmes and inadequate detail as to aspects of the theoretical models underpinning these programmes. Another issue that remains to be clarified concerns the intensity of training interventions (i.e., how much training is needed to produce meaningful changes), as there is currently no consensus with respect to the level of intensity and duration of these training interventions.

Secondly, there is limited empirical support regarding the generalizability of training-related improvements in emotion recognition skills to actual social functioning and to other functional domains. The degree to which affect recognition improvements extend to real-life functioning is unclear and limited. In terms of outcome measures, the majority of training studies to date have relied on pictures or other static stimuli, and it has been suggested that dynamic training stimuli (e.g., film clips) may evoke greater spontaneous facial mimicry (Johnston et al., 2008) and provide greater generalization to everyday social settings. The use of virtual reality environments has been suggested as an approach to rehabilitation that may help to increase the generalization of treatment effects to the real world (Baron-Cohen et al., 2009). It is therefore the prerogative of subsequent research to develop emotion recognition training programmes that more closely approximate real-life social settings. An important issue that remains to be clarified concerns the impediment cognitive deficits present to the capacity of individuals with TBI to transfer and/or apply skills from the emotion recognition training environment to their day-to-day living. A smartphone application with emotion recognition prompts that includes emotion recognition applications for people with TBI may perhaps address reduced cognitive capacities and facilitate people with TBI to recall strategies relating to emotion recognition and deploy them across real-world situations (Wilson, 2010). The development of training methods involving caregivers or significant others, may represent one approach that would possibly help also.

The third limitation relates to the sustainability of training-related improvement over time. Only a few studies, including this one, have addressed the duration of training effects, and most studies have generally involved relatively short-term follow up after training (i.e., less than six months afterwards). As the clinical utility of emotion recognition treatments remains unclear, there is a need for further studies that are much longer-term in nature.

Despite these limitations, several strengths of this research should be noted. These include the well-controlled clinical trial design, the use of randomization and allocation concealment, blinded outcome assessment, implementing designs with sufficient follow-up to evaluate treatment effect, a reasonably detailed neuropsychological evaluation, and the inclusion of informants' ratings rather than sole reliance on participant self-reports.

Future Research

While much progress has been made in understanding the mechanisms underlying facial affect recognition, the precise facets of this domain are still far from clear. Research therefore could continue to investigate the nature of facial affect recognition with functional imaging paradigms. Such knowledge may increase our understanding of the mechanisms underlying facial affect recognition deficits in TBI. Future researchers could assess the implicit and explicit emotion recognition in TBI, and explore which facets of emotion processing are actually impaired in people with TBI. Whether the intact emotion facets can itself be used by these people for succeeding on emotion recognition tasks warrants further investigation.

To better clarify the interrelationships between each of the cognitive domains and facial affect recognition after TBI, future studies could consider the use of statistical procedures such as structural modelling techniques. Longitudinal work using neuroimaging techniques and encompassing multiple time-points is also needed to establish whether spontaneous improvement in cognitive functioning during recovery is accompanied by improvement in facial affect recognition, and whether or not changes in cognitive functioning are a contributory factor for the restoration of facial affect recognition in TBI.

Another important avenue for future research is improvement in the facial affect recognition assessment instruments that are available for use in clinical trials. As the present research shows discrepant findings between two facial affect recognition measures, this raises concerns about the utility of the facial affect recognition measures used in TBI for clinical trials and their sensitivity to change in the context of treatment trials. Given the recent focus on developments to address emotion recognition deficits in TBI, it would be useful for researchers to continue developing new, sensitive, developmentally-appropriate performance measures that capture the range of facial affect recognition impairments in people with TBI and that are amenable for use in clinical trials. Another area that deserves further investigation is how psychometric properties of emotion recognition measures, for example internal consistency, may be impacted by individual differences in reduced capacity to recognise some facial expressions but not others.

It is important when evaluating the efficacy of emotion recognition training that researchers/clinicians should consider whether these programmes have been built on a theoretical understanding of the underlying mechanisms of facial affect recognition. Michie et al. (2005) outline the benefits of such frameworks in designing interventions. Frameworks can, for example, provide information as to which variables it is important to intervene with and which in turn are essential for guiding more effective training programmes. It is reasonable to assume that emotion recognition skills training programmes based on well-tested theoretical frameworks associated with the mechanisms underlying facial affect recognition are more likely to facilitate changes in affective processing. Future studies could therefore investigate and identify which theoretical models or which areas of specific models of facial affect recognition have not been examined and employed in the intervention approaches trialled to date. Such knowledge could provide guidance as to areas that should receive deliberate focus in future research and could potentially assist in the development of interventions to promote emotion recognition skills effectively for people with TBI.

Another consideration for future research is the relevance in Asian cultures of affect recognition treatments for people sustaining a TBI. Because the majority of existing clinical trials examining the efficacy of affect recognition treatment have been carried out with individuals with brain injury from Western cultures, they have limited generalizability across populations. To my knowledge, this no research or data available from an Asian (including Singaporean) context that has looked into the effects of training to improve emotion recognition in persons with TBI. It will be interesting for future studies to determine whether the effects of *Faces* treatment can be replicated for Asian people suffering from facial affect recognition impairments after brain injury. This may provide empirical evidence allowing cultural validation of the treatment (As I am currently based in Singapore, I have indicated the feasibility of carrying out a follow-up study in Singapore to my supervisor. This would need to be discussed further with the international team).

While this research provides support for the efficacy of the *Faces* training in helping TBI patients acquire affect recognition skills, additional investigation is needed to provide further support for these findings, as well as to verify the treatment's durability over a longer period of time. Given that adaptive social interactions require much more than an ability to recognise emotions conveyed through facial expression (it can also be inferred from social contextual cures), it will be interesting in future research to determine whether the integration with *Faces* treatment of exercise from the *Stories* treatment can produce synergistic effects on treatment outcome in people with TBI. It is also critical that the long-term benefits of affect recognition for other aspects of social cognition be investigated, and the degree to which the training transfers to patients' everyday social life. Finally, in addition to objective social functioning measures, future research could also include a qualitative component such as in-depth interviews to explore how participants' quality of life changes after the treatment. This would further examine potential benefits of the treatment programme for other aspects of recipients' well-being, such as self-esteem.

Conclusion

In conclusion, the present research suggests that retraining is possible for affect recognition difficulties after traumatic brain injury through a targeted emotion recognition intervention. This research indicated that the *Faces* treatment could be effective in enhancing facial affect recognition skills in people with TBI and that it may produce enduring effects. With regard to the *Stories* treatment, the findings of this research do not provide support for its efficacy in enhancing emotional inference abilities. Given the potential interest of the approach used in this second intervention, however, further research in this area could still be of value. Although neither treatment resulted in significant improvement in participants' social and interpersonal functioning, this research indicates that *Faces* training may increase participants' empathy behaviours and raises a possibility that the treatment may modulate affect recognition by increasing emotional awareness, although further investigation is required to clarify this.

The present research also suggests that impairment in several cognitive processes may contribute to facial affect recognition deficits in TBI, in particular nonverbal memory, working memory and speed of processing. Furthermore, it suggests that executive functioning may not be a critical factor in facial affect recognition, though it is reasonable to propose executive functioning would most likely be important in deciding what to do once facial affect is perceived.

Finally, this research suggests that age may be an important influence on long-term treatment response to *Faces* treatment. This finding warrants replication, and further studies are needed to consider the interaction between individual factors and treatment outcome. This research also illustrated that improvements in facial affect recognition abilities following *Faces* treatment are not necessarily dependent on cognitive functions, although they may be closely connected. There seems little doubt that the relationship between facial affect recognition impairments and cognitive dysfunction in TBI will be complex and multifactorial, and may be partly influenced by the target of intervention, task difficulty, make-up of emotional stimuli, individual differences in facial affect recognition impairments, and processing style.

Future studies need to replicate the promising training effects of *Faces* treatment across different clinical settings to establish its efficacy. It is important to understand the biological, cognitive and environmental mechanisms through which *Faces* training intervention influences the treatment outcomes of people with TBI and their subsequent social behaviours. More research is needed to uncover the actual mechanisms underlying facial affect recognition processing deficits in TBI and the actual contribution of cognitive functioning in these deficits so that effective interventions might be devised to ameliorate or at least compensate for them. Expansion of such knowledge would require large samples of people with TBI, longitudinal intervention studies, and a multi-method approach with a multi-disciplinary perspective. Single case experimental designs could also be considered to provide further meaningful information about plausible application in frontline clinical services.

Although interventions for affect recognition after TBI require much further development, affect recognition training holds promise as a practical rehabilitative tool, contributing to the ultimate goal of assisting people with TBI to have a meaningful quality of life.

References

Aalto, A.-M., Elovainio, M., Kivimäki, M., Uutela, A., & Pirkola, S. (2012). The Beck Depression Inventory and General Health Questionnaire as measures of depression in the general population: a validation study using the Composite International Diagnostic Interview as the gold standard. *Psychiatry Research, 197*, 163-171.

Aarsland, D., Larsen, J. P., Lim, N. G., Janvin, C., Karisen, K., Tandberg, E., & Cummings, J. L. (1999). Range of neuropsychiatric disturbances in patients with Parkinson's disease. *Journal of Neurology, Neurosurgery & Psychiatry with Practical Neurology, 67*, 492-496.

Adams, M. P. (2011). Modularity, theory of mind, and autism spectrum disorder. *Philosophy of Science, 78*, 763-773.

Addington, J., Girard, T. A., Christensen, B. K., & Addington, D. (2010). Social cognition mediates illness-related and cognitive influences on social function in patients with schizophrenia-spectrum disorders. *Journal of Psychiatry and Neuroscience, 35*, 49-54.

Addington, J., Saeedi, H., & Addington, D. (2006). Facial affect recognition: A mediator between cognitive and social functioning in psychosis. *Schizophrenia Research, 85*, 142-150.

Adolphs, R. (2002). Recognizing emotion from facial expressions: psychological and neurological mechanisms. *Behavioral and Cognitive Neuroscience Reviews, 1*, 21-61.

Adolphs, R. (2010). Conceptual challenges and directions for social neuroscience. *Neuron, 65*, 752-767.

Adolphs, R., Damasio, H., Tranel, D., Cooper, G., & Damasio, A. R. (2000). A role for somatosensory cortices in the visual recognition of emotion as revealed by three-dimensional lesion mapping. *Journal of Neuroscience 20*, 2683-2690.

Adolphs, R., Gosselin, F., Buchanan, T. W., Tranel, D., Schyns, P., & Damasio, A. R. (2005). A mechanism for impaired fear recognition after amygdala damage. *Nature 433*, 68-72.

Adolphs, R., & Tranel, D. (2004). Impaired judgments of sadness but not happiness following bilateral amygdala damage. *Journal of Cognitive Neuroscience, 16*, 453-462.

Allerdings, M. D., & Alfano, D. P. (2006). Neuropsychological correlates of impaired emotion recognition following traumatic brain injury. *Brain and Cognition, 60*, 193-194.

Ambadar, Z., Schooler, J. W., & Cohn, J. F. (2005). Deciphering the enigmatic face: the importance of facial dynamics in interpreting subtle facial expressions. *Psychological Science, 16*, 403-410.

Arango-Lasprilla, J. C., Ketchum, J. M., Dezfulian, T., Kreutzer, J. S., O'Neil-Pirozzi, T. M., Hammond, F., & Jha, A. (2008). Predictors of marital stability 2 years following traumatic brain injury. *Brain Injury, 22*, 565-574.

Archer, T., Svensson, K., & Alricsson, M. (2012). Physical exercise ameliorates deficits induced by traumatic brain injury. *Acta Neurologica Scandinavica, 125*, 293-302.

Babbage, D. R., Yim, J., Zupan, B., Neumann, D., Tomita, M. R., & Willer, B. (2011). Meta-analysis of facial affect recognition difficulties after traumatic brain injury. *Neuropsychology, 25*, 277-285.

Babbage, D. R., Zupan, B., Neumann, D., & Willer, B. (2012, July). *Rasch analysis of the DANVA2 Adult Faces and Voices in people with traumatic brain injury.* Paper presented at the 9th Conference of the Neuropsychological Rehabilitation Special Interest Group of the World Federation for NeuroRehabilitation, Bergen, Norway.

Baron-Cohen, S., Golan, O., & Ashwin, E. (2009). Can emotion recognition be taught to children with autism spectrum conditions? *Philosophical Transactions of The Royal Society, 364*, 3567-3574.

Baron-Cohen, S., & Wheelwright, S. (2004). The empathy quotient: an investigation of adults with asperger syndrome or high functioning autism, and normal sex differences. *Journal of Autism and Developmental Disorders, 34*, 163-175.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistically considerations. *Journal of Personality and Social Psychology, 51*, 1173-1182.

Barrett, L. F., Lindquist, K. A., & Gendron, M. (2007). Language as context for the perception of emotions. *Trends in Cognitive Sciences, 11*, 327-331.

Barrett, L. F., Mesquita, B., & Gendron, M. (2011). Context in emotion perception. *Current Directions in Psychological Science, 20*, 286-290.

Barrett, L. F., & Wager, T. D. (2006). The structure of emotion: evidence from neuroimaging studies. *Current Directions in Psychological Science, 15*, 79-83.

Bazin, N., Brunet-Gouet, E., Bourdet, C., Kayser, N., Falissard, B., Hardy-Bayle, M. V., & Passerieuz, C. (2009). Quantitative assessment of attribution of intentions to others in schizophrenia using an ecological video-based task: a comparison with manic and depressed patients. *Psychiatry Research, 167*, 28-35.

Beauchamp, M. H., & Anderson, V. (2010). SOCIAL: An integrative framework for the development of social skills. *Psychological Bulletin, 136*, 39-64.

Bechi, M., Riccaboni, R., Ali, S., Fresi, F., Buonocore, M., Bosia, M., . . . Cavallaro, R. (in press). Theory of mind and emotion processing training for patients with schizophrenia: preliminary findings. *Psychiatry Research*, 1-7.

Beck, A. T., Steer, R. A., & Brown, G. (1996). *Beck Depression Inventory II Manual* San Antonio, TX: The Psychological Corporation.

Bibby, H., & McDonald, S. (2005). Theory of mind after traumatic brain injury. *Neuropsychologia, 43*, 99-114.

Biele, C., & Grabowska, A. (2006). Sex differences in perception of emotion intensity in dynamic and static facial expression. *Experimental Brain Research, 171*, 1-6.

Bölte, S., Hubl, D., Feineis-Matthews, S., Prvulovic, D., Dierks, T., & Poustka, F. (2006). Facial affect recognition training in autism: Can we animate the fusiform gyrus? *Behavioral Neuroscience, 120*, 211-216.

Boraston, Z., Blakemore, S. J., Chilvers, R., & Skuse, D. (2007). Impaired sadness recognition is linked to social interaction deficit in autism. *Neuropsychologia, 45*, 1501-1510.

Borgaro, S. R., Prigatano, G. P., Kwasnica, C., Alcott, S., & Cutter, N. (2004). Disturbances in affective communication following brain injury. *Brain Injury, 18*, 33-39.

Borm, G. F., Fransen, J., & Lemmens, W. A. (2007). A simple sample size formula for analysis of covariance in randomized clinical trials. *Journal of Clinical Epidemiology, 60*, 1234-1238.

Bornhofen, C., & McDonald, S. (2008a). Emotion perception deficits following traumatic brain injury: A review of the evidence and rationale for intervention. *Journal of the International Neuropsychological Society, 14*, 511-525.

Bornhofen, C., & McDonald, S. (2008b). Treating deficits in emotion perception following traumatic brain injury. *Neuropsychological Rehabilitation, 18*, 22-44.

Bornhofen, C., & McDonald, S. (2008c). Comparing strategies for treating emotion perception deficits in traumatic brain injury. *Journal of Head Trauma Rehabilitation, 23*, 103-115.

Bourne, V. J. (2008). Examining the relationship between degree of handedness and degree of cerebral lateralization for processing facial emotion. *Neuropsychology, 22*, 350-356.

Bowers, D., Blonder, L. X., & Heilman, K. M. (1991). *Florida Affect Battery*. Gainesville: University of Florida.

Braun, C., Baribeau, J., Ethier, M., Daigneault, S., & Proulx, R. (1989). Processing of pragmatic and facial affective information by patients with closed-head injuries. *Brain Injury, 3*, 5-17.

Brookshire, R. H., & Nicholas, L. E. (1993). *The discourse comprehension test*. Tucson, AZ: Communication Skill Builders/The Psychological Corporation.

Brüne, M., Schaub, D., Juckel, G., & Langdon, R. (2011). Social skills and behavioral problems in schizophrenia: the role of mental state attribution, neurocognition and clinical symptomatology. *Psychiatry Research, 190*, 9-17.

Bryson, G., Bell, M., & Lysaker, P. (1997). Affect recognition in schizophrenia: a function of global impairment or a specific cognitive deficit. *Psychiatry Research, 71*, 105-113.

Buccino, G., Binkofski, F., Fink, G. R., Fadiga, L., Fogassi, L., Gallese, V., . . . Freund, H. J. (2001). Action observation activates premotor and parietal areas in a somatotopic manner: An fMRI study. *European Journal of Neuroscience, 13*, 400-401.

Burridge, A. C., Williams, W. H., Yates, P. J., Harris, A., & Ward, C. (2007). Spousal relationship satisfaction following acquired brain injury: the role of insight and socio-emotional skill. *Neuropsychological Rehabilitation, 17*, 95-105.

Button, K. S., Ioannidis, J. P., Mokrysz, C., Nosek, B. A., Flint, J., Robinson, E. S., & Munafò, M. R. (2013). Power failure: why small sample size undermines the reliability of neuroscience. *Nature Reviews Neuroscience*.

Byom, L. J., & Turkstra, L. (2012). Effects of social cognitive demand on theory of mind in conversations of adults with traumatic brain injury. *International Journal of Language & Communication Disorders 47*, 310-321.

Calder, A. J., & Young, A. W. (2005). Understanding the recognition of facial identity and facial expression. *Nature Reviews Neuroscience 6*, 641-651.

Camozzato, A. L., Kochhann, R., Simeoni, C., Konrath, C. A., Pedro Franz, A., Carvalho, A., & Chaves, M. L. (2008). Reliability of the Brazilian Portuguese version of the Neuropsychiatric Inventory (NPI) for patients with Alzheimer's disease and their caregivers. *International Psychogeriatrics, 20*, 383-393.

Carla, S. (2008). Theory of mind and conduct problems in children: deficits in reading the "emotions of the eyes". *Cognition and Emotion, 22*, 1149-1158.

Carr, L., Iacoboni, M., Dubeau, M. C., Mazziotta, J. C., & Lenzi, G. L. (2003). Neural mechanisms of empathy in humans: A relay from neural systems for imitation to limbic areas. *Proceedings of the National Academy of Sciences, 100*, 5497-5502.

Channon, S., Pellijeff, A., & Rule, A. (2005). Social cognition after head injury: sarcasm and theory of mind. *Brain and Language, 93*, 123-134.

Chepenik, L. G., Cornew, L. A., & Farah, M. J. (2007). The influence of sad mood on cognition. *Emotion, 7*, 802-811.

Cherniss, C. (2010). Emotional intelligence: towards clarification of a concept. *Industrial and Organizational Psychology, 3*, 110-126.

Cicerone, K. D., Dahlberg, C., Malec, J. F., Langenbahn, D. M., Felicetti, T., Kneipp, S., . . . Catanese, J. (2005). Evidence-based cognitive rehabilitation: updated review of the literature from 1998 through 2002. *Archives of Physical Medicine and Rehabilitation, 86*, 1681-1692.

Cicerone, K. D., Langenbahn, D. M., Braden, C., Malec, J. F., Kalmar, K., Fraas, M., . . . Ashman, T. (2011). Evidence-based cognitive rehabilitation: updated review of the literature from 2003 through 2008. *Archives of Physical Medicine and Rehabilitation, 92*, 519-530.

Clark, U. S., Neargarder, S., & Cronin-Golomb. (2008). Specific impairments in the recognition of emotional facial expressions in Parkinson's disease. *Neuropsychologia, 46*, 2300-2309.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). New Jersey: Lawrence Erlbaum Associates.

Colantonio, A., Ratcliff, G., Chase, S., Kelsey, S., Escobar, M., & Vernich, L. (2004). Long term outcomes after moderate to severe traumatic brain injury. *Disability and Rehabilitation, 26*, 253-261.

Combs, D. R., Tosheva, A., Penn, D. L., Basso, M. R., Wanner, J. L., & Laib, K. (2008). Attentional-shaping as a means to improve emotion perception deficits in schizophrenia. *Schizophrenia Research 105*, 68-77.

Connor, D. J., Sabbagh, M. N., & Cummings, J. L. (2008). Comment on administration and scoring of the Neuropsychiatric Inventory in clinical trials. *Alzheimer's and Dementia, 4*, 390-394.

Critchley, H., Daly, E., Phillips, M., Brammer, M., Bullmore, E., Williams, S., . . . Murphy, D. (2000). Explicit and implicit neural mechanisms for processing of social information from facial expressions: a functional magnetic resonance imaging study. *Human Brain Mapping 9*, 93-105.

Croker, V., & McDonald, S. (2005). Recognition of emotion from facial expression following traumatic brain injury. *Brain Injury, 19*, 787-799.

Crowe, S. F. (2008). *The behavioural and emotional complications of traumatic brain injury*. New York: Taylor & Francis Group

Cummings, J. L. (1997). The Neuropsychiatric Inventory: assessing assessment of psychopathology in dementia. *Neurology, 48*, 10-16.

Cummings, J. L., Mega, M., Gray, K., Rosenberg-Thompson, S., Carusi, D. A., & Gornbein, J. (1994). The Neuropsychiatric Inventory: comprehensive assessment of psychopathology in dementia. *Neurology, 44*, 2308-2314.

Dalemans, R. J., de Witte, L. P., Beurskens, A. J., van den Heuvel, W. J., & Wade, D. T. (2010). Psychometric properties of the community integration questionnaire adjusted for people with aphasia. *Archives of Physical Medicine and Rehabilitation, 91*, 395-399.

Dapretto, M., Davies, M. S., Pfeifer, J. H., Scott, A. A., Sigman, M., Bookheimer, S. Y., & Iacoboni, M. (2005). Understanding emotions in others: mirror neuron dysfunction in children with autism spectrum disorders. *Nature Neuroscience, 9*, 28-30.

Darby, D., Maruff, P., Collie, A., & McStephen, M. (2002). Mild cognitive impairment can be detected by multiple assessments in a single day. *Neurology, 59*, 1042-1046.

Davis, M. H. (1980). A multidimensional approach to individual differences in empathy. *JSAS Catalog of Selected Documents in Psychology, 10*, 85-100.

Davis, M. H. (1983). Measuring individual differences in empathy: evidence for a multidimensional approach. *Journal of Personality and Social Psychology, 44*, 113-126.

Davison, S. L., Bell, R. J., Gavrilescu, M., Searle, K., Maruff, P., Gogos, A., . . . Davis, S. R. (2011). Testosterone improves verbal learning and memory in postmenopausal women: results from a pilot study. *Maturitas, 70*, 307-311.

de Sousa, A., McDonald, S., Rushby, J., Li, S., Dimoska, A., & James, C. (2010). Why don't you feel how I feel? Insight into the absence of empathy after severe traumatic brain injury. *Neuropsychologia, 48*, 3585-3595.

de Villiers, J. (2007). The interface of language and theory of mind. *Lingua, 117*, 1858-1878.

Decety, J. (2011). Dissecting the neural mechanisms mediating empathy. *Emotion Review, 3*, 92-108.

Dennis, M., Agostino, A., Roncadin, C., & Levin, H. (2009). Theory of mind depends on domain-general executive functions of working memory and cognitive inhibition in children with traumatic brain injury. *Journal of Clinical and Experimental Neuropsychology, 31*, 835-847.

Dikmen, S. S., Corrigan, J. D., Levin, H. S., Machamer, J., Stiers, W., & Weisskopf, M. G. (2009). Cognitive outcome following traumatic brain injury. *Journal of Head Trauma Rehabilitation, 24*, 430-438.

Dingwall, K. M., Maruff, P., Fredrickson, A., & Cairney, S. (2011). Cognitive recovery during and after treatment for volatile solvent abuse. *Drug and Alcohol Dependence 118*, 180-185.

Douglas, A. M., Porter, R. J., Knight, R. G., & Maruff, P. (2011). Neuropsychological change and treatment response in severe depression. *The British Journal of Psychiatry, 198*, 115-122.

Douglas, J. M., & Spellacy, F. J. (1996). Indicators of long-term family functioning following severe traumatic brain injury in adults. *Brain Injury, 10*, 819-839.

Dozois, D. J. A., & Covin, R. (Eds.). (2004). *The Beck Depression Inventory-II (BDI-II), Beck Hopelessness Scale (BHS), and Beck Scale for Suicide Ideation (BSS).* Hoboken, NJ: John Wiley & Sons.

Draper, K., & Ponsford, J. (2008). Cognitive functioning ten years following traumatic brain injury and rehabilitation. *Neuropsychology, 22*, 618-625.

Driscoll, D. M., Dal Monte, O., & Grafman, J. (2011). A need for improved training interventions for the remediation of impairments in social functioning following brain injury. *Journal of Neurotrauma, 28*, 319-326.

Durand, K., Gallay, M., Seigneuric, A., Robichon, F., & Baudouin, J. Y. (2007). The development of facial emotion recognition: the role of configural information. *Journal of Experimental Child Psychology, 97*, 14-27.

Eisenbarth, H., & Alpers, G. W. (2011). Happy mouth and sad eyes: scanning emotional facial expressions. *Emotion, 4*, 860-865.

Ekman, P. (2003). Darwin, deception, and facial expression *Annals New York Academy of Sciences, 1000*, 205-221.

Ekman, P. (2004). *Emotions revealed: recognising faces and and feelings to improve communication and emotional life* New York: Owl Books.

Engell, A. D., & Haxby, J. V. (2007). Facial expression and gaze-direction in human superior temporal sulcus. *Neuropsychologia, 45*, 3234-3241.

Falleti, M. G., Maruff, P., Collie, A., & Darby, D. G. (2006). Practice effects associated with the repeated assessment of cognitive function using the CogState battery at 10-minute, one week and one month test-retest intervals. *Journal of Clinical and Experimental Neuropsychology, 28*, 1095-1112.

Field, A. (2009). *Discovering statistics using SPSS (and sex and drugs and rock 'n' roll)* (3rd ed.). London: SAGE Publications Ltd.

Fisher, N., Happe, F., & Dunn, J. (2005). The relationship between vocabulary, grammar and false belief task performance in children with autistic spectrum disorders with moderate learning difficulties. *Journal of Child Psychology and Psychiatry, 40*, 409-419.

Flashman, L. A., & McAllister, T. W. (2002). Lack of awareness and its impact in traumatic brain injury. *NeuroRehabilitation, 17*, 285-296.

Fleming, J., & Ownsworth, T. (2006). A review of awareness interventions in brain injury rehabilitation. *Neuropsychological Rehabilitation, 16*, 474-500.

Fontaine, A., Azouvi, P., Remy, P., Bussel, B., & Samson, Y. (1999). Functional anatomy of neuropsychological deficits after severe traumatic brain injury. *Neurology, 53*, 1963-1968.

Fredrickson, J., Maruff, P., Woodward, M., Moore, L., Fredrickson, A., Sach, J., & Darby, D. (2010). Evaluation of the usability of a brief computerized cognitive screening test in older people for epidemiological studies. *Neuepidemiology 34*, 65-75.

Fusar-Poli, P., Placentino, A., Carletti, F., Landi, P., Allen, P., Surguladze, S., . . . Politi, P. (2009). Functional atlas of emotional faces processing: a voxel-based meta-analysis of 105 functional magnetic resonance imaging studies. *Journal of Psychiatry and Neuroscience, 34*, 418-432.

Gamer, M., & Büchel, C. (2009). Amygdala activation predicts gaze toward fearful eyes. *The Journal of Neuroscience, 29*, 9123-9126.

Garcia-Villamisar, D., Rojahn, J., Zaja, R. H., & Jodra, M. (2010). Facial emotion processing and social adaptation in adults with and without autism spectrum disorder. *Research in Autism Spectrum Disorders, 4*, 755-762.

Gendron, M., Lindquist, K. A., Barsalou, L., & Barrett, L. F. (2012). Emotion words shape emotion percepts. *Emotion, 12*, 314-325.

Gibbs, R. W. (2002). A new look at literal meaning in understanding what is said and implicated. *Journal of Pragmatics, 34*, 457-486.

Gllick, B. T., & Zirpel, L. (2012). Neuroplasticity: Synapse to System. *Archives of Physical Medicine and Rehabilitation, 93*, 1846-1855.

Golan, O., & Baron-Cohen, S. (2006). Systemizing empathy: teaching adults with Asperger syndrome or high-functioning autism to recognise complex emotions using interactive multimedia. *Development and Psychopathology, 18*, 591-617.

Goldman, A. I., & Sripada, C. S. (2005). Simulationist models of face-based emotion recognition. *Cognition, 94*, 193-213.

Green, R. E. A., Turner, G. R., & Thompson, W. F. (2004). Deficits in facial emotion perception in adults with recent traumatic brain injury. *Neuropsychologia, 42*, 133-141.

Grimshaw, G. M., Bulman-Fleming, M. B., & Ngo, C. (2004). A signal-detection analysis of sex differences in the perception of emotional faces. *Brain and Cognition, 54*, 248-250.

Guercio, J. M., Podolska-Schroeder, H., & Rehfeldt, R. A. (2004). Using stimulus equivalence technology to teach emotion recognition to adults with acquired brain injury. *Brain Injury, 18*, 593-601.

Gur, R. C., Sara, R., Hagendoorn, M., Marom, O., Hughett, P., Macy, L., . . . Gur, R. E. (2002). A method for obtaining 3-dimensional facial expressions and its standardization for use in neurocognitive studies. *Journal of Neuroscience Methods, 115*, 137-143.

Hadwin, J., Baron-Cohen, S., Howlin, P., & Hill, K. (1996). Can we teach children with autism to understand emotions, beliefs, or pretence? *Development and Psychopathology, 8*, 345-365.

Halberstadt, A. G., Dennis, P. A., & Hess, U. (2011). The influence of family expressiveness, individuals' own emotionality, and self-expressiveness on perceptions of others' facial expressions. *Journal of Nonverbal Behaviour, 35*, 35-50.

Hall, J. A., Bernieri, F. J., & Carney, D. R. (2005). Nonverbal behavior and interpersonal sensitivity. In J. A. Harrigan, R. Rosenthal & K. R. Scherer (Eds.), *The new handbook of methods in nonverbal behavior research* (pp. 237-281). New York: Oxford University Press.

Harms, M. B., Martin, A., & Wallace, G. L. (2010). Facial emotion recognition in autism spectrum disorders: a review of behavioral and neuroimaging studies. *Neuropsychology Review, 20*, 290-322.

Haxby, J. V., Hoffman, E. A., & Gobbini, M. I. (2000). The distributed human neural system for face perception. *Trends in Cognitive Sciences 4*, 223-233.

Heberlein, A. S., & Atkinson, A. P. (2009). Neuroscientific evidence for simulation and shared substrates in emotion recognition: beyond faces. *Emotion Review, 1*, 162-177.

Heberlein, A. S., Padon, A. A., Gillihan, S. J., Farah, M. J., & Fellows, L. K. (2008). Ventromedial frontal lobe plays a critical role in facial emotion recognition. *Journal of Cognitive Neuroscience, 20*, 721-733.

Henry, J. D., Bailey, P. E., von Hippel, C., Rendell, P. G., & Lane, A. (2010). Alexithymia in schizophrenia. *Journal of Clinical and Experimental Neuropsychology*, *7*, 890-897.

Henry, J. D., Phillips, L. H., Beatty, W., McDonald, S., Longley, W. A., Joscelyne, A., & Rendell, P. G. (2009a). Evidence for deficits in facial affect recognition and theory of mind in multiple sclerosis. *Journal of the International Neuropsychological Society*, *15*, 277-285.

Henry, J. D., Phillips, L. H., Beatty, W. W., McDonald, S., Longley, W. A., Joscelyne, A., & Rendell, P. G. (2009b). Evidence for deficits in facial affect recognition and theory of mind in multiple sclerosis. *Journal of the International Neuropsychological Society, 15*, 277-285.

Henry, J. D., Phillips, L. H., Crawford, J. R., Ietswaart, M., & Summers, F. (2006). Theory of mind following traumatic brain injury: the role of emotion recognition and executive dysfunction. *Neuropsychologia, 44*, 1623-1628.

Holahan, C. J., Moos, R. H., Holahan, C. K., Brennan, P. L., & Schutte, K. K. (2005). Stress generation, avoidance coping, and depressive symptoms: a 10-year model. *Journal of Consulting and Clinical Psychology 73*, 658-666.

Homaifar, B. Y., Brenner, L. A., Gutierrez, P. M., Harwood, J. F., Thompson, C., Filley, C. M., . . . Adler, L. E. (2009). Sensitivity and specificity of the Beck Depression Inventory-II in persons with traumatic brain injury. *Archives of Physical Medicine and Rehabilitation, 90*, 652-656.

Hoofien, D., Gilboa, A., Vakil, E., & Donovick, P. (2001). Traumatic brain injury (TBI) 10-20 years later: a comprehensive outcome study of psychiatric symptomatology, cognitive abilities, and psychosocial functioning. *Brain Injury, 15*, 189-209.

Hopkins, M. J., Dywan, J., & Segalowitz, S. J. (2002). Altered electrodermal response to facial expression after closed head injury. *Brain Injury, 16*, 245-257.

Horan, W. P., Kern, R. S., Penn, D. L., Green, M. F., & Penn, D. L. (2008). Social cognition training for individuals with schizophrenia: emerging evidence. *American Journal of Psychiatric Rehabilitation, 11*, 205-252.

Horan, W. P., Kern, R. S., Shokat-Fadai, K., Sergi, M. J., Wynn, J. K., & Green, M. F. (2009). Social cognitive skills training in schizoprenia: An initial efficacy study of stabilized outpatients. *Schizophrenia Research, 107*, 47-54.

Hornak, J., Bramhan, J., Rolls, E. T., Morris, R. G., O'Doherty, J., Bullock, P. R., & Polkey, C. E. (2003). Changes in emotion after circumscribed surgical lesions of the orbitofrontal and cingulate cortices. *Brain, 126*, 1691-1712.

Hornak, J., Rolls, E. T., & Wade, D. (1996). Face and voice expression identification in patients with emotional and behavioural changes following ventral lobe damage. *Neuropsychologia, 34*, 247-261.

Huebner, R. A., Johnson, K., Bennett, C. M., & Schneck, C. (2003). Community participation and quality of life outcomes after adult traumatic brain injury. *American Journal of Occupational Therapy, 57*, 177-185.

Ietswaart, M., Milders, M., Crawford, J. R., Currie, D., & Scott, C. L. (2008). Logitudinal aspects of emotion recognition in patients with traumatic brain injury. *Neuropsychologia, 46*, 148-159.

Issacowitz, D. M., Lockenohoff, C. E., Lane, R. D., Wright, R., Sechrest, L., Riedel, R., & Costa, P. T. (2007). Age differences in recognition of emotion in lexical stimuli and facial expressions. *Psychology and Aging, 22*, 147-159.

Izard, C., Fine, S., Schultz, D., Mostow, A., Ackerman, B., & Youngstrom, E. (2001). Emotion knowledge as a predictor of school behaviour and academic competence in children at risk. *Psychological Science, 12*, 18-23.

Jackson, H. F., & Moffat, N. J. (1987). Impaired emotion recognition following severe head injury. *Cortex, 23*, 293-300.

Jackson, P. L., Meltzoff, A. N., & Decety, J. (2005). How do we perceive the pain of others? A window into the neural processes involved in empathy. *Neuroimage, 24*, 771-779.

Johnston, P. J., Enticott, P. G., Mayes, A. K., Hoy, K. E., Herring, S. E., & Fitzgerald, P. B. (2008). Symptom correlates of static and dynamic facial affect processing in schizophrenia: evidence of a double dissociation? . *Schizophrenia Bulletin, 36*, 680-687.

Johnston, P. J., Enticott, P. G., Mayes, A. K., Hoy, K. E., Herring, S. E., & Fitzgerald, P. B. (2010). Symptoms correlates of static and dynamic facial affect processing in schizophrenia: evidence of a double dissociation? *Schizophrenia Bulletin, 36*, 680-687.

Jumisko, E., Lexell, J., & Soderberg, S. (2005). The meaning of living with traumatic brain injury in people with moderate or severe traumatic brain injury. *Journal of Neurosciences Nursing, 37*, 42-50.

Karow, C. M., Marquardt, T. P., & Marshall, R. C. (2001). Affective processing in left and right hemisphere brain-damaged subjects with and without subcortical involvement. *Aphasiology, 15*, 715-729.

Kee, K. S., Gree, M. F., Mintz, J., & Brekke, J. S. (2003). Is emotional processing a predictor of functional outcome in schizophrenia? *Schizophrenia Bulletin, 29*, 487-497.

Kersel, D. A., Marsh, N. V., Havills, J. H., & Sleigh, J. W. (2001). Psychosocial functioning during the year following severe traumatic brain injury. *Brain Injury, 15*, 683-696.

Keysers, C., & Gazzola, V. (2009). Expanding the mirror: vicarious activity for actions, emotions, and sensations. *Current Opinion in Neurobiology, 19*, 666-671.

Kilmer, R. P., Demakis, G. J., Hammond, F. M., Grattan, K. E., Cook, J. R., & Kornev, A. A. (2006). Use of the Neuropsychiatric Inventory in traumatic brain injury: a pilot investigation. *Rehabilitation Psychology, 51*, 232-238.

Kim, J., & Andre, E. (2008). Emotion recognition based on physiological changes in music listening. *IEEE Transactions on Pattern Analysis and Machine Intelligence, 30*, 2067-2083.

Knox, L., & Douglas, J. (2009). Long-term ability to interpret facial expression after traumatic brain injury and its relation to social integration. *Brain and Cognition, 69*, 442-449.

Krishnamoorthy, E. S., & Trimble, M. R. (2008). Prevalence, patterns, service needs, and assessment of neuropsychiatric disorders among people with epilepsy in residential care: validation of the Neuropsychiatric Inventory as a caregiver-rated measure of neuropsychiatric functioning in epilepsy. *Epilepsy & Behavior, 13*, 223-228.

Kubu, C. S. (1999). Emotion recognition & psychosocial behavior in closed-head injury. In N. R. Varney & R. J. Roberts (Eds.), *The evaluation & treatment in mild traumatic brain injury*. (pp. 451-461). New Jersey: Erlbaum.

Kucharska-Pietura, K., Phillips, M. L., Gernand, W., & David, A. S. (2003). Perception of emotions from faces and voices following unilateral brain damage. *Neuropsychologia, 41*, 1082-1090.

Kurth, F., Zilles, K., Fox, P. T., Laird, A. R., & Eickhoff, S. B. (2010). A link between the systems: Functional differentiation and integration within the human insula revealed by meta-analysis. *Brain Structure and Function, 214*, 519-534.

Lacava, P. G., Golan, O., Baron-Cohen, & Myles, B. S. (2007). Using assistive technology to teach emotion recognition to students with Asperger syndrome. *Remedial and Special Education, 28*, 174-181.

Langlois, J. A., Rutland-Brown, W., & Wald, M. (2006). The epidemiology and impact of traumatic brain injury: a brief overview. *The Journal of Head Trauma Rehabilitation, 21*, 375-378.

Laurent, S. M., & Hodges, S. D. (2009). Gender roles and empathic accuracy: the role of communion in reading minds. *Sex Roles, 60*, 387-398.

Laxe, S., Tschiesner, U., Zasler, N., López-Blazquez, R., Tormos, J. M., & Bernabeu, m. (in press). What domains of the International Classification of Functioning, Disability and Health are covered by the most commonly used measurement instruments in traumatic brain injury research? *Clinical Neurology and Neurosurgery, 114*, 645-650.

Leathem, J. M., Murphy, L. J., & Flett, R. A. (1998). Self- and informant-ratings on the Patient Competency Rating Scale in patients with traumatic brain injury. *Journal of Clinical and Experimental Neuropsychology, 20*, 694-705.

Lee, S. J., Lee, H. K., Kweon, Y. S., Lee, C. T., & Lee, K. U. (2009). The impact of executive function on emotion recognition and emotion experience in patients with schizophrenia. *Psychiatry Investigation, 6*, 156-162.

Lefebvre, H., Cloutier, G., & Levert, M. J. (2008). Perspectives of survivors of traumatic brain injury and their caregivers on long-term social integration. *Brain Injury, 22*, 535-543.

Levin, H. S., Grafman, J., & Eisenberg, H. M. (1987). *Neurobehavioral recovery from head injury*. New York: Oxford University.

Lillard, A. S., & Erisir, A. (2011). Old dogs learning new tricks: Neuroplasticity beyond the juvenile period. *Developmental Review, 31*, 207-239.

Loh, S. Y. (2009). Baseline adjustment for statistical efficiency on clinical controlled trial. *Journal of the University of Malaya Medical Centre, 12*, 31-34.

Maas, A. I., Stocchetti, N., & Bullock, R. (2008). Moderate to severe traumatic brain injury in adults. *The Lancert Neurology, 7*, 728-741.

Mah, L. W. Y., Arnold, M. C., & Grafman, J. (2005). Deficits in social knowledge following damage to ventromedial prefrontal cortex. *The Journal of Neuropsychiatry and Clinical Neurosciences*, *17*, 66-74.

Makdissi, M., Collie, A., Maruff, P., Darby, D. G., Bush, A., McCrory, P., & Bennell, K. (2001). Computerized computer cognitive assessment of concussed Australian Rules footballers. *British Journal of Sports Medicine, 35*, 354-360.

Mandal, M. K., Tandon, S., & Asthana, H. S. (1991). Right brain damage impairs recognition of negative emotions. *Cortex, 27*, 247-253.

Marsh, N. V., Kersel, D. A., Havill, J. A., & Sleigh, J. W. (2002). Caregiver burden during the year following severe traumatic brain injury. *Journal of Clinical and Experimental Neuropsychology, 24*, 434-447.

Martin-Rodriguez, J. F., & León-Carrión, J. (2010). Theory of mind deficits in patients with acquired brain injury: a quantitative review. *Neuropsychologia, 48*, 1181-1191.

Martins, A. T., Fáisca, L., Esteves, F., Simão, C., Justo, M. G., Muresan, A., & Reis, A. (2012). Changes in social emotion recognition following traumatic frontal lobe injury. *Neural Regeneration Research, 7*, 101-108.

Maruff, P., Thomas, E., Cysique, L., Brew, B., Collie, A., Snyder, P., & Pietrzak, R. H. (2009). Validity of the CogState brief battery: relationship to standardized tests and sensitivity to cognitive impairment in mild traumatic brain injury, schizophrenia and aids dementia complex. *Archives of Clinical Neuropsychology, 24*, 165-178.

Mathersul, D., Palmer, D. M., Gur, R. C., Gur, R. E., Cooper, N., Gordon, E., & Williams, L. M. (2009). Explicit identification and implicit recognition of facial emotions: II. Core domains and relationships with general cognition. *Journal of Clinical and Experimental Neuropsychology, 31*, 278-291.

Matsumoto, D., Keltner, D., Shiota, M. N., O'Sullivan, M., & Frank, M. (2008). Facial expressions of emotions. In M. Lewis, J. M. Haviland-Jones & L. Feldman-Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 211-234). New York: The Guilford Press.

Mazza, M., Lucci, G., & Pacitti. (2010). "Could schizophrenic subjects improve their social cognition abilities only with observation and imitation of social situations?". *Neuropsychological Rehabilitation*, *20*, 675-703.

McCabe, K. L., Loughland, C. M., Hunter, M., Lewin, T., & Carr, V. J. (2010). A bottom-up biofeedback remediation improves emotion recognition in schizophrenia: evidence from a visual scan path pilot study. *Schizophrenia Research*, *117*, 177-178.

McCleary, L. (2002). Using multiple imputation for analysis of incomplete data in clinical research. *Nursing Research, 51*, 339-343.

McCrimmon, S., & Oddy, M. (2006). Return to work following moderate-to-severe traumatic brain injury. *Brain Injury, 20*, 1037-1046.

McDonald, S. (2013). Impairments in social cognition following severe traumatic brain injury. *Journal of the International Neuropsychological Society*, *19*, 231-246.

McDonald, S., Bornhofen, C., & Hunt, C. (2009a). Addressing deficits in emotion recognition after severe traumatic brain injury: the role of focused attention and mimcry. *Neuropsychological Rehabilitation, 19*, 321-339.

McDonald, S., Bornhofen, C., & Hunt, C. (2009b). Addressing deficits in emotion recognition after severe traumatic brain injury: the role of focused attention and mimicry. *Neuropsychological Rehabilitation, 19*, 321-339.

McDonald, S., Flanagan, S., Rollins, J., & Kinch, J. (2003). TASIT: A new clinical tool for assessing social perception after traumatic brain injury. *The Journal of Head Trauma Rehabilitation, 18*, 219-238.

McDonald, S., Li, S., De Sousa, A., Rushby, J., Dimoska, A., James, C., & Tate, R. L. (2011). Impaired mimicry response to angry faces following severe traumatic brain injury. *Journal of Clinical and Experimental Neuropsychology, 33*, 17-29.

Medalia, A., & Saperstein, A. (2011). The role of motivation for treatment success. *Schizophrenia Bulletin, 37*, 122-128.

Middleton, J. A. (2001). Brain injury in children and adolescents. *Advances in Psychiatric Treatment, 7*, 257-265.

Mier, D., Lis, S., Neuthe, K., Sauer, C., Esslinger, C., Gallhofer, B., & Kirsch, P. (2010). The involvement of emotion recognition in affective theory of mind. *Psychophysiology 47*, 1028-1039.

Milders, M., Fuchs, S., & Crawford, J. R. (2003). Neuropsychological impairments and changes in emotional and social behaviour following severe traumatic brain injury. *Journal of Clinical and Experimental Neuropsychology, 25*, 157-172.

Money, C., Davies, H., & Tchanturia, K. (2011). A case study introducing cognitive remediation and emotion skills training for anorexia nervosa inpatient care. *Clinical Case Studies, 10*, 110-121.

Montagne, B., Kessels, R. P., De Haan, E. H., & Perret, D. I. (2007). The emotion recognition task: a paradigm to measure the perception of facial emotional expressions at different intensities. *Perceptual and Motor Skills*, *104*, 589-598.

Moos, R. H., Brennan, P. L., Schutte, K. K., & Moos, B. S. (2010). Spouses of older adults with late-life drinking problems: health, family and social functioning. *Journal of Studies on Alcohol and Drugs, 71,* 506-514.

Moos, R. H., & Moos, B. S. (1994). *Life Stressors and Social Resources Inventory: adult form manual.* Odessa, FI.: Psychological Assessment Resources.

Muller, F., Simion, A., Reviriego, E., Galera, C., Mazaux, J. M., Barat, M., & Joseph, P. A. (2010). Exploring theory of mind after severe traumatic brain injury. *Cortex*, *46*, 1088-1099.

Murphy, F. C., Nimmo-Smith, I., & Lawrence, A. D. (2003). Functional neuroanatomy of emotions: a meta-analysis. *Cognitive, Affective, & Behavioral Neuroscience, 3*, 207-233.

Neumann, D., Zupan, B., Babbage, D. R., Radnovich, A. J., Tomita, M., Hammond, F., & Willer, B. (2012). Affect recognition, empathy and dysosmia after traumatic brain injury. *Archives of Physical Medicine and Rehabilitation, 93*, 1414-1420.

New Zealand Guidelines Group. (2006). *Traumatic brain injury: diagnosis, acute management and rehabilitation*. Wellington: Accident Compensation Corporation.

Niemeier, J. P., Marwitz, J. H., Lesher, K., Walker, W. C., & Bushnik, T. (2007). Gender differences in executive functions following traumatic brain injury. *Neuropsychological Rehabilitation, 17*, 293-313.

Nijboer, T. C. W., & Jellema, T. (2012). Unequal impairment in the recognition of positive and negative emotions after right hemisphere lesions: a left hemisphere bias for happy faces. *Journal of Neuropsychology, 6*, 79-93.

Nowicki, S. (2010). *Manual for the receptive tests of the Diagnostic Analysis of Nonverbal Accuracy 2*. (Unpublished manuscript). Department of Psychology, Emory University, Atlanta, GA.

Nowicki, S., & Carton, E. (1997). The relation of nonverbal processing ability of faces and voices and children's feelings of depression and competence. *The Journal of Genetic Psychology, 158*, 357-363.

Nowicki, S., & Duke, M. (1994). Individual differences in the nonverbal communication of affect: the diagnostic analysis of nonverbal accuracy scale. *Journal of Nonverbal Behavior, 18*, 9-35.

Nowicki, S., & Hartigan, M. (1988). Accuracy of facial affect recognition as a function of locus of control orientation and anticipated interpersonal interaction. *The Journal of Social Psychology 128*, 363-372.

Nuevo, R., Lehtinen, V., Reyna-Liberato, P. M., & Ayuso-Mateos, J. L. (2009). Usefulness of the Beck Depression Inventory as a screening method for depression among the general population of Finland. *Scandinavian Journal of Public Health, 37*, 28-34.

Nummenmaa, L., Hirvonen, J., Parkkola, P., & Hietanen, J. K. (2008). Is emotional contagion special? An fMRI study on neural systems of affective cognitive empathy. *Neuroimage, 43*, 571-580.

Oberman, L. M., Winkielman, P., Vilayanur, S., & Ramachandran, S. (2007). Face to face: blocking facial mimicry can selectively impair recognition of emotional expressions. *Social Neuroscience, 2*, 167-178.

Ownsworth, T., & Fleming, J. (2005). The relative importance of metacognitve skills, emotional status, and executive functions in psychosocial adjustments following acquired brain injury. *Journal of Head Trauma Rehabilitation, 20*, 315-332.

Pelphrey, K. A., & Carter, E. J. (2008). Brain mechanisms for social perception: lessons from autism and typical development. *Annals of the New York Academy of Sciences, 1145*, 283-299.

Penfield, W. (1958). Some mechanisms of consciousness discovered during electrical stimulation of the brain. *National Academy of Sciences, 44*, 51-66.

Penton-Voak, I. S., Bate, H., Lewis, G., & Munafò, M. R. (2012). Effects of emotion perception training on mood in undergraduate students: randomized controlled trial. *The British Journal of Psychiatry, 201*, 71-72.

Peterson, C. C., Garnett, M., Kelly, A., & Attwood, T. (2009). Everyday social and conversation applications of theory-of-mind understanding by children with autism-spectrum disorders or typical development. *European Child & Adolescent Psychiatry 18*, 105-115.

Pettersen, L. (1991). Sensitivity to emotional cues and social-behavior in children and adolescents after head-injury. *Perceptual and Motor Skills, 73*, 1139-1150.

Phillips, L. H., Channon, S., Tunstall, M., Hedenstrom, A., & Lyons, K. (2008). The role of working memory in decoding emotions. *Emotion, 8*, 184-191.

Pineda, J. A., & Hecht, E. (2009). Mirroring and mu rhythm involvement in social cognition: Are there dissociable subcomponents of theory of mind? *Biological Psychology, 80*, 306-314.

Pinkham, A. E., Penn, D. L., Perkins, D. O., & Lieberman, J. (2003). Implications for the neural basis of social cognition for the study of schizophrenia. *The American Journal of Psychiatry, 160*, 815-824.

Pitcher, D., Garrido, L., Walsh, V., & Duchaine, B. C. (2008). Transcranial magnetic stimulation disrupts the perception and embodiment of facial expressions. *The Journal of Neuroscience, 28*, 8929-8933.

Ponsford, J., Draper, K., & Schönberger, M. (2008). Functional outcome 10 years after traumatic brain injury: its relationship with demographic, injury severity, and cognitive and emotional status. *Journal of the International Neuropsychological Society, 14*, 233-242.

Ponsford, J., Olver, J., Ponsford, M., & Nelms, R. (2003). Long-term adjustment of families following traumatic brain injury where comprehensive rehabilitation has been provided. *Brain Injury, 17,* 453-468.

Ponsford, J., & Schönberger, M. (2010). Family functioning and emotional state two and five years after traumatic brain injury. *Journal of the International Neuropsychological Society, 16,* 306-317.

Prigatano, G. P. (2005). Therapy for emotional and motivational disorders. In W. M. H. Jr, A. M. Sander, M. A. Struchen & K. A. Hart (Eds.), *Rehabilitation for traumatic brain injury* (pp. 118-130). New York: Oxford University Press.

Prigatano, G. P., & Pribram, K. H. (1982). Perception and memory of facial affect following brain injury. *Perceptual and Motor Skills, 54*, 859-869.

Quintana, D. S., Guastella, A. J., Outhred, T., Hickie, I. B., & Kemp, A. H. (in press). Heart rate variability is associated with emotion recognition: direct evidence for a relationship between the autonomic nervous system and social cognition. *International Journal of Psychophysiology*.

Radice-Neumann, D., Zupan, B., Babbage, D. R., & Willer, B. (2007). Overview of impaired facial affect recognition in persons with traumatic brain injury. *Brain Injury, 21*, 807-816.

Radice-Neumann, D., Zupan, B., Tomita, M., & Willer, B. (2009). Training emotional processing in persons with brain injury. *Journal of Head Trauma Rehabilitation, 24*, 313-323.

Raush, J. R., Maxwell, S. E., & Kelley, K. (2003). Analytic methods for questions pertaining to a randomized pretest, posttest, follow-up design. *Journal of Clinical Child and Adolescent Psychology, 32*, 467-486.

Riggio, R. E., Tucker, J., & Coffaro, D. (1989). Social skills and empathy. *Personality and Individual Differences, 10*, 93-99.

Roebuck-Spencer, T., & Sherer, M. (2008). Moderate and severe traumatic brain injury. In J. E. Morgan & J. H. Ricker (Eds.), *Textbook of clinical neuropsychology* (pp. 411-429). New York: Taylor & Francis.

Rohling, M. L., Faust, M. E., Beverly, B., & Demakis, G. (2009). Effectiveness of cognitive rehabilitation following acquired brain injury: a meta-analytic re-examination of Cicerone et al.'s (2000, 2005) systematic reviews. *Neuropsychology*, *23*, 20-39.

Ruffman, T., Henry, J. D., Livingstone, V., & Phillips, L. H. (2008). A meta-analytic review of emotion recognition and aging: implications for neuropsychological models of aging. *Neuroscience and Biobehavioural Reviews, 32*, 863-881.

Ruttan, L., Martin, K., Liu, A., Colella, B., & Green, R. E. (2008). Long-term cognitive outcome in moderate to severe traumatic brain injury: a meta-analysis examining timed and untimed tests at 1 and 4.5 or more years after injury. *Archives of Physical Medicine and Rehabilitation, 89*, S69-S76.

Ryan, C., & Charragáin, C. N. (2010). Teaching emotion recognition skills to children with autism. *Journal of Autism and Developmental Disorders, 40*, 1505-1511.

Sachs, G., Steger-Wuchse, D., Kryspin-Exner, I., Gur, R. C., & Katschnig, H. (2004). Facial recognition deficits and cognition in schizophrenia. *Schizophrenia Research, 68*, 27-35.

Saeki, S., Okazaki, T., & Hachisuka, K. (2006). Concurrent validity of the community integration questionnaire in patients with traumatic brain injury in Japan. *Journal of Rehabilitation Medicine*, *38,* 333-335.

Said, C. P., Dotsch, R., & Todorov, A. (2010). The amygdala and FFA track both social and non-social face dimensions. *Neuropsychologia*, *48*, 3596-3605.

Salter, K., Foley, N., Jutai, J., Bayley, M., & Teasell, R. (2008). Assessment of community integration following traumatic brain injury. *Brain Injury, 22*, 820-835.

Sander, A. M., & Struchen, M. A. (2011). Interpersonal relationships and traumatic brain injury. *Journal of Head Trauma Rehabilitation, 26*, 1-3.

Santoro, J., & Spiers, M. (1994). Social cognitive factors in brain injury-associated personality change. *Brain Injury, 8,* 265-276.

Sato, W., Kochiyama, T., Yoshikawa, S., Naito, E., & Matsumura, M. (2004). Enhanced neural activity in response to dynamic facial expressions of emotions: an fMRI study. *Brain Research: Cognitive Brain Research*, *20*, 81-91.

Schafer, J. L. (1999). Multiple imputation: a primer. *Statistical Methods in Medical Research, 8*, 3-15.

Schafer, J. L., & Graham, J. W. (2002). Missing data: our view of the state of art. *Psychological Methods, 7,* 147-177.

Schlomer, G. L., Bauman, S., & Card, N. A. (2010). Best practices for missing data management in counseling psychology. *Journal of Counseling Psychology, 57*, 1-10.

Schmid, P. C., & Mast, M. S. (2010). Mood effects on emotion recognition. *Motivation and Emotion, 34*, 288-292.

Schneider, J. A., Boyle, P. A., Arvanitakis, Z., Bienias, J. L., & Bennett, D. A. (2007). Subcortical infarcts, Alzheimer's disease pathology, and memory function in older persons. *Annals of Neurology, 62*, 59-66.

Schwab, K., Grafman, J., Salazar, A. M., & Kraft, J. (1993). Residual impairments and work status 15 years after penetrating head injury: Report from the Vietnam Head Injury Study. *Neurology, 43*, 95-103.

Schwaninger, A., Wallraven, C., Cunningham, D. W., & Chiller-Glaus, S. D. (2006). Processing of facial identity and expression: a psychophysical, physiological, and computational perspective *Progress in Brain Research, 156*, 321-343.

Shamay-Tsoory, S. G., Aharon-Peretz, J., & Perry, D. (2008). Two systems for empathy: a double dissociation between emotional and cognitive empathy in inferior frontal gyrus versus ventromedial prefrontal lesions. *Brain, 132*, 617-627.

Shamay-Tsoory, S. G., Shur, S., Barcai-Goodman, L., Medlovich, S., Harari, H., & Levkovitz, Y. (2007). Dissociation of cognitive from affective components of theory of mind in schizophrenia. *Psychiatry Research, 149*, 11-23.

Shamay-Tsoory, S. G., Tomer, R., & Aharon-Peretz, J. (2005). The neuroanatomical basis of understanding sarcasm and its relationship to social cognition. *Neuropsychology, 19*, 288-300.

Sheaffer, B. L., Golden, J. A., & Averett, P. (2009). Facial expression recognition deficits and faulty learning: implications for theoretical models and clinical application *International Journal of Behavioral Consultation and Therapy, 5*, 31-55.

Sherer, M., Bergloff, P., Levin, E., High, W., Oden, K. E., & Nick, T. G. (1998b). Impaired awareness and employment outcome after traumatic brain injury. *Journal of Head Trauma Rehabilitation, 13*, 52-61.

Sherer, M., Hart, T., & Nick, T. G. (2003a). Measurement of impaired self-awareness after traumatic brain injury: A comparison of the patient competency rating scale and the awareness questionnaire. *Brain Injury, 4*, 380-387.

Shorland, J., & Douglas, J. M. (2010). Understanding the role of communication in maintaining and forming friendships following traumatic brain injury. *Brain Injury, 24*, 569-580.

Silver, M., & Oakes, P. (2001). Evaluation of a new computer intervention to teach people with autism or Asperger syndrome to recognize and predict emotions in others. *Autism, 5*, 299-316.

Simmons, W. K., Avery, J. A., Barcalow, J. C., Bodurka, J., Drevets, W. C., & Bellgowan, P. (in press). Keeping the body in mind: insula functional organization and functional connectivity integrate interoceptive, exteroceptive, and emotional awareness *Human Brain Mapping*, 1-15.

Sloan, S., Winkler, D., & Anson, K. (2007). Long-term outcome following traumatic brain injury. *Brain Impairment, 8*, 251-261.

Spell, L. A., & Frank, E. (2000). Recognition of nonverbal communication of affect following traumatic brain injury. *Journal of Nonverbal Behavior, 24*, 285-300.

Spikman, J. M., Timmerman, M. E., Milders, M. V., Veenstra, W. S., & van der Naalt, J. (2012). Social cognition impairments in relation to general cognitive deficits, injury severity and prefrontal lesions in traumatic brain injury patients. *Journal of Neurotrauma, 20*, 101-111.

Stålnacke, B.-M. (2007). Community integration, social support and life satisfaction in relation to symptoms 3 years after mild traumatic brain injury. *Brain Injury, 21*, 933-942.

Stancin, T., Wade, S. L., Walz, N. C., Yeates, K. O., & Taylor, H. G. (2010). Family adaptation 18 months after traumatic brain injury in early childhood. *Journal of Developmental & Behavioral Pediatrics, 31*, 317-325.

Suchy, Y., Rau, H., Whittaker, W. J., Eastvold, A., & Strassberg, D. L. (2009). Facial affect recognition as a predictor of performance on a reading comprehension test among criminal sex offenders. *Applied Psychology in Criminal Justice, 5*, 73-89.

Sullivan, S., Ruffman, T., & Hutton, S. B. (2007). Age differences in emotion recognition skills and the visual scanning of emotion faces. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences, 62*, 53-60.

Tager-Flusberg, H., & Sullivan, K. (2000). A componential view of theory of mind: evidence from Williams syndrome. *Cognition, 76*, 59-89.

Teasdale, G., & Jennett, B. (1976). Assessment and prognosis of coma after head injury. *Acta Neurochirgica, 34*, 45-55.

Testa, J. A., Malec, J. F., Moessner, A. M., & Brown, A. W. (2006). Predicting family functioning after TBI: impact of neurobehavioral factors. *Journal of Head Trauma Rehabilitation, 21*, 236-247.

Thayer, J. F., & Johnson, B. H. (2000). Sex differences in judgement of facial affect: a multivariate analysis of recognition errors. *Scandinavian Journal of Psychology, 41*, 243-246.

Thompson, R. A. (1987). Development of children's inference of the emotions of others. *Developmental Psychology, 23,* 124-131.

Tonks, J., Williams, H. W., Frampton, I., Yates, P., Wall, S. E., & Slater, A. (2008). Reading emotions after childhood brain injury: case series evidence of dissociation between cognitive abilities and emotional expression processing skills. *Brain Injury, 22*, 325-332.

Tracy, S. W., Kelly, J. F., & Moos, R. H. (2005). The influence of partner status, relationship quality and relationship stability on outcomes following intensive substance-use disorder treatment. *Journal of Studies on Alcohol, 66,* 497-505.

Tsaousides, T., Ashman, T., & Seter, C. (2008). The psychological effects of employment after traumatic brain injury: objective and subjective indicators. *Rehabilitation Psychology, 53,* 456-463.

Vassallo, S., Douglas, J., & White, E. (2011). Visual scanning in the recognition of facial affect in traumatic brain injury. *Perception 2*, 250.

Watanabe, Y., Shiel, A., Asami, T., Taki, K., & Tabuchi, K. (2000). An evaluation of neurobehavioural problems as perceived by family members and levels of family stress 1-3 years following traumatic brain injury in Japan. *Clinical Rehabilitation, 14*, 172-177.

Watts, A. J., & Douglas, J. M. (2006). Interpreting facial expression and communication competence following severe traumatic brain injury. *Aphasiology, 20*, 707-722.

Watts, A. J., & Douglas, J. M. (2006). Interpreting facial expression and communication competence following severe traumatic brain injury. *Aphasiology, 20*, 707-722.

Weiner, B., Sandra, G., Stern, P., & Lawson, M. (1982). Using affective cues to infer causal thoughts. *Developmental Psychology, 18*, 278-286.

West, J. T., Horning, S. M., Klebe, K. J., Foster, S. M., Cornwell, R. E., Perrett, D., . . . Davis, H. P. (2012). Age effects on emotion recognition in facial displays: from 20 to 89 years of age. *Experimental Aging Research: An International Journal Devoted to the Scientific Study of the Aging Process, 38*, 146-168.

Willer, B., Ottenbacher, K. J., & Coad, M. L. (1994). The community integration questionnaire: a comparative examination. *The American Journal of Physical Medicine and Rehabilitation, 73,* 103-111.

Willer, B., Rosenthal, M., Kreutzer, J. S., Gordon, W. A., & Rempel, R. (1993). Assessment of community integration following rehabilitation for traumatic brain injury. *Journal of Head Trauma Rehabilitation, 8,* 75-87.

Williams, C., & Wood, R. L. (2010). Impairment in the recognition of emotion across different media following traumatic brain injury. *Journal of Clinical and Experimental Neuropsychology, 32*, 113-122.

Williams, L. M., Das, P., Liddell, B., Olivieri, G., Peduto, A., Brammer, M. J., & Gordon, E. (2005). BOLD, sweat and fears: fMRI and skin conductance distinguish facial fear signals. *Neuroreport, 16,* 49-52.

Wilson, B. A. (2010). Brain injury: recovery and rehabilitation. *Wiley Interdisciplinary Reviews: Cognitive Science, 1*(1), 108-118. doi: 10.1002/wcs.15

Wood, A. M., White, I. R., & Thompson, S. G. (2004). Are missing outcome data adequately handled? A review of published randomized controlled trials in major medical journals. *Clinical Trials, 1,* 368-376.

Wood, P. M., & Kroese, B. S. (2007). Enhancing the emotion recognition skills of individuals with learning disabilities: a review of the literature. *Journal of Applied Research in Intellectual Disabilities 20*, 576-579.

Wood, R. L. (2008). Long-term outcome of serious traumatic brain injury. *European Journal of Anaesthesiology, 25*, 115-122.

Wood, R. L., Liossi, C., & Wood, L. (2005). The impact of head injury neurobehavioural sequelae on personal relationships: preliminary findings. *Brain Injury, 19*, 845-851.

Wood, R. L., & Williams, C. (2008). Inability to empathize following traumatic brain injury. *Journal of the International Neuropsychological Society, 14*, 289-296.

Xi, C., Zhu, Y., Niu, C., Zhu, C., Lee, T. M. C., Tian, Y., & Wang, K. (2011). Contributions of subregions of the prefrontal cortex to the theory of mind and decision making. *Behavioural Brain Research, 221*, 587-593.

Yim, J., Babbage, D. R., Zupan, B., Neumann, D., & Willer, B. (accepted pending minor revision). The relationship between facial affect recogntion and cognitive functioing after traumatic brain injury. *Brain Injury*.

Zupan, B. (2009). Emotional inferencing stories task: Poster presented at: the Department of Applied Linguistics Research Day. St. Catharines, ON: Brock University.

Zupan, B., Neumann, D., Babbage, D. R., & Willer, B. (2009). The importance of vocal affect to bimodal processing of emotion: implications for individuals with traumatic brain injury. *Journal of Communication Disorders, 42*, 1-17.

Appendices

Appendix A: Screening and Other Outcome Measures

Demographic characteristics

Demographic variables included age, gender, ethnicity, marital status, living situation, education, sensory functioning, employment status and injury severity. Information regarding injury severity was either abstracted from medical records or obtained during interview sessions. The injury severity variables assessed were the date, cause and severity of injury as by the Glasgow Coma Scale scores, and the length of unconsciousness or the post-traumatic amnesia. Additional information such as a participant's past medical and mental health history, neuroimaging abnormalities, alcohol and drug use and current medication was also obtained during the initial screening assessment.

Discourse Comprehension Test (DCT; Brookshire & Nicholas, 1993)

The DCT was used to measure general language comprehension. We used a modified task developed from the DCT (Brookshire & Nicholas, 1993). Two stories from the DCT were used (Appendix B provides one of these). Each story was around 200 words long, so approximately two minutes when presented orally. Participants were first given a story to read on their own. If they failed to supply correct answers to six out of eight questions relating to it, they listened to another story which was presented to them orally. If they then failed to answer at least six out of eight questions correctly, they were ineligible for the study. The DCT has been used effectively both for people with brain injury (Ferstl, Walther, Guthke, & von Cramon, 2005) and people with Parkinson's Disease (Murray & Stout, 1999). The DCT was administered to participants at screening only.

The Emotional Descriptor Test (Braun, Baribeau, Ethier, Daigneault, & Proulx, 1989)

This test examines an individual's ability to understand words relating to emotion. It consists of eight brief situations extracted from the Emotional Context test (Braun et al., 1989). Each situation was described in one sentence, and participants had to identify from a list of four emotions how most people would feel in that situation. Participants who answered five out of eight questions correctly were included in the study as having shown adequate understanding of words referring to emotion. Participants completed the Emotional Descriptor Test during the initial screening assessment.

The Line Cancelation Test

The Line Cancelation test was used to rule out visual neglect. Participants were instructed to use their dominant hand to cross out every line presented on a 20 X 26 cm piece of paper placed horizontally. There were 40 lines in total, each 2.5 cm in length, drawn in an apparently random manner on the paper. The test paper was placed in front of the participant (at their midline). Scoring was based on the number and location of lines left uncrossed (Albert, 1973). Participants completed this test during the initial screening assessment.

Facial identity discrimination, subtest 1 of the Florida Affect Battery (Bowers, Blonder, & Heilman, 1991)

This test assesses a person's ability to discriminate between the "same" and "different" neutral faces. In this task, each screen showed two photographs in which the model had a neutral facial expression. On half the occasions the two photographs were the same; on the other half, the photographs were of different people. The participants had to decide whether or not the photographs were of the same person. The Facial identity discrimination task acts as a perceptual control for the facial affect tasks. This test was administered to participants at pre-test.

Vocal Affect Recognition

The Diagnostic Analysis of Nonverbal Accuracy 2—Adult Paralanguage task (DANVA2-AP) and three subtests 8a, 8b, and 9 of the Florida Affect Battery (FAB) were used to assess prosodic emotional processing (auditory). The DANVA2-AP was administered at screening, pre-test, post-test, and at three-and six-month follow-ups. The three subtests 8a, 8b, and 9 of the FAB were administered at post-test and 3 month follow-up only.

DANVA2-AP (Baum & Nowicki, 1998)

The DANVA2-AP consists of 24 verbal statements by adults. In this task, participants are presented with an audio clip, recorded in the computer programme, of the sentence, "I am going out of the room now, but I'll be back later". The statements varied with paralinguistic cues that expressed different emotions. Participants selected the expressed emotion from a list of the following: happiness, sadness, anger, and fear. Test scores ranged from 0 to 24. The DANVA2-AP is a standardized test with age-related norms. It is a widely used measure across all races, sexes, ages, and populations, including TBI (Radice-Neumann, Zupan, Tomita, & Willer, 2009; Spell & Frank, 2000). Test-retest reliability ranged from .73 to .93 in a study of three different age groups over four weeks.

Naming the Emotional Prosody, subtest 8a of the Florida Affect Battery (Bowers, Blonder, & Heilman, 1998)
In this task, participants are required to verbally label affective prosody from 20 semantically neutral sentences spoken in one of five affective tones (happy, sad, angry, fearful neutral).The Florida Affect Battery has good test-retest reliability (subtest r values range from .89 to .97) and good construct validity (Bowers et al., 1998).

Conflicting Emotional Prosody, subtest 8b of the Florida Affect Battery (Bowers et al., 1998)
This task required participants to listen to affectively intoned sentences in which the semantic content either differed from (i.e., was incongruent with) or paralleled (i.e. was congruent with) the message. ‘All the puppies are dead’ said in a happy tone of voice) was incongruent with the message; ‘all the puppies are dead’ said sadly, was congruent with it.

Matching Emotional Prosody to the Emotional Face , subtest 9 of the Florida Affect Battery (Bowers et al., 1998)
In this task, participants first listened to a series of semantically neutral sentences that were presented by a female voice in five affective tones (happy, sad, angry, fearful, neutral). They were then presented on the computer screen with three photographs of the same woman expressing different emotions. From this set of three, participants were required to associate the affective tone of the female voice with the facial expression of the female face on one of the photographs.

The Brief Smelling Identification Test-version A (B-SIT; Doty, Marcus, & Lee, 1996)
The ability to identify odours was tested with the B-SIT (Doty et al., 1996). This test consists of 12 scratch and sniff pads which release an odour when scratched with pencil. Examinees are/were required to choose the correct odour from four options. The number of correct answers from 12 possible correct answers was totalled and compared with values determined by defining “normal” or “abnormal” olfactory function

according to age and sex. Performance on B-SIT has been shown to have good reliability and validity, and has normative scores derived from 3760 participants (Doty et al., 1996). The B-SIT has recently shown to be sensitive in detecting odour impairments in individuals with TBI (Neumann et al., 2012). The B-SIT was administered to participants at screening only.

References

Albert, M. L. (1973). A simple test of visual neglect. *Neurology, 23*, 658-664.

Baum, K., & Nowicki, S. J. (1998). Perception of emotion: measuring decoding accuracy of adult prosodic cues varying intensity. *Journal of Nonverbal Behavior, 22,* 89-109.

Bowers, D., Blonder, L. X., & Heilman, K. M. (1991). *Florida Affect Battery*. Gainesville: University of Florida.

Bowers, D., Blonder, X. L., & Heilman, K. M. (1998). *Florida Affect Battery*. Gainesville, FL: University of Florida, Center for Neuropsychological Studies.

Braun, C., Baribeau, J., Ethier, M., Daigneault, S., & Proulx, R. (1989). Processing of pragmatic and facial affective information by patients with closed-head injuries. *Brain Injury, 3,* 5-17.

Brookshire, R. H., & Nicholas, L. E. (1993). *The discourse comprehension test*. Tucson, AZ: Communication Skill Builders/The Psychological Corporation.

Doty, R. L., Marcus, A., & Lee, W. W. (1996). Development of the 12-item Cross-Cultural Smell Identification Test (CC-SIT). *Laryngoscope, 106,* 353-356.

Ferstl, E. C., Walther, K., Guthke, T., & von Cramon, D. Y. (2005). Assessment of story comprehension deficits after brain damage. *Journal of Clinical and Experimental Neuropsychology, 27,* 367-384.

Murray, L. L., & Stout, J. C. (1999). Discourse comprehension in Huntington's and Parkinson's diseases. *American Journal of Speech-Language Pathology, 8,* 137-148.

Neumann, D., Zupan, B., Babbage, D. R., Radnovich, A. J., Tomita, M., Hammond, F., & Willer, B. (2012). Affect recognition, empathy and dysosmia after traumatic brain injury. *Archives of Physical Medicine and Rehabilitation, 93,* 1414-1420.

Radice-Neumann, D., Zupan, B., Tomita, M., & Willer, B. (2009). Training emotional processing in persons with brain injury. *Journal of Head Trauma Rehabilitation, 24*, 313-323.

Spell, L. A., & Frank, E. (2000). Recognition of nonverbal communication of affect following traumatic brain injury. *Journal of Nonverbal Behaviour, 24*, 285-300.

Appendix B: Description of CogState Measures

1. Continuous Paired Association Learning Task

A picture was presented in the centre of the screen. The participant was asked to remember where the picture was located and tap where that picture had previously appeared.

2. One Back Task

A card was presented in the middle of the screen. When a new card was presented, the participant was required to indicate whether the new card was the same as or different from the previously presented card by pressing the "K" key if it was the same or the "D" key if it was different.

3. Identification Task

Using the same single card presentation format, the participant was required to respond to the colour of the card by pressing the "K" key if the card was red and the "D" key if the card was black.

4. Set-Shifting Task

A card was presented in the centre of the screen with the world "NUMBER" or COLOUR" above it. The participant had to guess whether the card was the "target" or "correct" card and determine whether it contained a target stimulus dimension (a colour or a number). If the guess was correct, the card would flip over; if the guess was incorrect, the participant would hear an ‘error’ sound and the card would not flip over.

5. Detection Task

A single card was presented face down in the centre of the computer screen. The participant was required to press the "space bar" key whenever the card turned face up.

6. International Shopping List Task

A list of 16 shopping items was read to the participant over three learning trials. The participant was required to remember as many items from the list as possible.

7. International Shopping List Task - Delayed Recall

After a 20-minute delay, the participant was required to recall as many items from the shopping list as he/she could remember.

8. Social Cognition

Three types of emotional stimuli were presented to the participant: computer generated male faces depicting certain facial expressions; pictures of male and female eyes displaying emotions; and eye gaze direction (a control task). Each stimulus was presented on a computer screen for 15 seconds; the participants had to choose the picture that was different out of a group of four by responding with a key press.

Appendix C: Information Sheet for Participant

Massey University
WELLINGTON

PSYCHOLOGY CLINIC
24 King Street
Mt Cook
Private Box 756
Wellington 6140
New Zealand
T 64 4 801 0492
F 64 4 801 0493
www.massey.ac.nz

Information Sheet

Recognising emotions after brain injury

You are invited to take part in a study to determine the benefit of new therapeutic approaches for people with traumatic brain injury (TBI). The purpose of this study is to evaluate the effectiveness of three therapy programs to improve skills related to emotion and cognition in adults with TBI.

What does taking part involve?

Screening: If you choose to take part, you will first be tested to determine eligibility for further participation. This session will last approximately 2.5 to 3 hours. This assessment will examine various aspects of your cognitive functioning using formal cognitive tests, and ask questions about your mood, behaviour, and relationship quality. You will also be asked to identify a person (e.g. spouse, significant other, parent) whom you feel knows you best, in order to complete some questionnaires about these same issues. You will be notified of your eligibility within three working days of the screening.

Pretest: If you are found eligible for the study, you will be asked to return in around 3 weeks for more tests, taking about two hours. You will then be randomised (selected by chance) to receive one of three therapy programs.

Treatment sessions: Therapy will be three times a week for 3 weeks, one hour each session—a total of nine sessions. These meetings will take place at our clinic in Wellington, or at a rehabilitation facility near your home, depending on what is possible and what is convenient for you.

Treatment 1: Participants will work on the computer to learn how to process information from faces. They will work with the therapist to understand the importance of this skill, how to improve it, and how it applies to their life.

Treatment 2: Participants will read and answer questions from stories on the computer. They will work with the therapist to learn how to improve this skill and discuss how it applies to their lives.

Treatment 3: Participants will engage in "brain" games on the computer. They will work with the therapist to learn how to improve the skills addressed in the games and how the skills apply to their lives.

Follow-up: After the treatment is completed, you will be asked to return three more times for testing, each time for about two hours:

1) within 4 days after treatment ends,
2) again 3 months after treatment ends, and
3) six months after treatment ends.

The study is being conducted as part of an international collaboration with colleagues in the United States and Canada. If you choose to participate in the study, you will be one of approximately 25 people with TBI who will be involved in this research project at our clinic. Your participation in the study may span the course of eight months.

By participating in this study valuable information will be learned about the capability of new types of therapy to address the emotional and cognitive challenges that are common after TBI. The findings and treatments from this study will be made available to clinicians and consumers so that they can be incorporated into treatment approaches if they are found to be effective.

How were people selected to take part in this study?
You may have been invited to participate in the study because you have been a client of the Psychology Clinic at Massey University or another brain injury rehabilitation service—if so, a clinician indicated you could be a suitable person to participate in this study. You may have been involved in a previous study that examined the prevalence of these issues, and have indicated you would be happy to be contacted about this ongoing research programme.

To take part in this study you need to be between 16 and 65 years old, and have had a moderate to severe traumatic brain injury at least one year ago. You must have adequate vision, hearing and communication abilities to be able to complete the task requirements. You must not be diagnosed with a mental illness other than depression. You must not be abusing alcohol or using an uncontrolled substance.

Are there any benefits or risks?
There is potential to improve your skills related to cognition and emotional processing. If you do not choose to participate in this study, you will continue to receive the health care that is currently being provided to you.

For your participation in this study, you will receive partial reimbursement for your expenses and effort in attending the testing sessions. All participants who complete screening will receive $20. If you are eligible and continue the study, you will receive $20 for each additional testing session. In addition, if after the study we find that one of the treatments is significantly more beneficial than the one you received, you will be given the opportunity to receive the other treatment.

Additional Cost
There will be no additional cost to you for participating in the study. All study-related work is paid for through a grant from the United States federal funding agency the National Institute on Disability and Rehabilitation Research (NIDRR) and by Massey University.

What will happen to the information collected in the study?
The things you say and the information we gather about you will be kept confidential and used for research purposes only. With your consent we would contact your GP to request updates regarding any medications you may be taking during the trial and the follow-up period that could affect your progress. No material that identifies you will be used in any report on this project. We will store your information in a secure location, and only those involved in this research programme will be able to see it. This may include research collaborators at overseas sites who are part of this research project. They are equally commited to maintaining your privacy, and only anonymous information (information recorded without your name) would ever be transferred to another site. We will store your information for at least ten years after the end of the project, after which time our records will be securely destroyed.

Taking part in this study is voluntary.
It is your choice whether you participate. You do not have to take part in this study. If you do agree to take part, you can stop at any stage without having to give a reason and this will not affect your continuing health care.

Please feel free to talk with a friend or family member if you need help to make the decision about whether to take part or not. Also, you are welcome to have a support person to be with you when we meet. You can ask questions about the study at any time.

Compensation for Injury
In the unlikely event of a physical injury as a result of your participation in this study, you may be covered by the Accident Compensation Corporation (ACC) under the Injury Prevention, Rehabilitation and Compensation Act. ACC cover is not automatic and your case will need to be assessed by ACC according to the provisions of the 2002 Injury Prevention Rehabilitation and Compensation Act. If your claim is accepted by ACC, you still might not get any compensation. This depends on a number of factors such as whether you are an earner or non-earner. ACC usually provides only partial reimbursement of costs and expenses and there may be no lump sum compensation payable. There is no cover for mental injury unless it is a result of physical injury. If you have ACC cover, generally this will affect your right to sue the investigators.

If you have any questions about ACC, contact your nearest ACC office or the investigator.

Finding out about the results of the study.
If you would like to find out the results of the project, tick YES on the consent form. After the project is completed, we will mail you the results. There may be a long delay between when you take part and when results are known.

If you would like more information about the study, feel free to contact:

Dr. Duncan Babbage telephone: 04 801 5799 ext. 62039
Psychology Clinic, Massey University, Private Box 756, Wellington

If you have any queries or concerns about your rights as a participant in this research study you can contact an independent health and disability advocate. This is a free service provided under the Health and Disability Commissioner Act.

Telephone: (NZ wide): 0800 555 050
Free Fax (NZ wide): 0800 2787 7678 (0800 2 SUPPORT)
Email (NZ wide): advocacy@hdc.org.nz

This study has received ethical approval from the Central Regional Ethics Committee which reviews National and Multi regional studies.

Jackki Yim
Doctoral Candidate

Duncan Babbage, PhD
Senior Lecturer, Clinic Director
New Zealand Principal Investigator

Appendix D: Information Sheet for Participant (Overview)

Massey University
WELLINGTON

PSYCHOLOGY CLINIC
24 King Street
Mt Cook
Private Box 756
Wellington 6140
New Zealand
T 64 4 801 0492
F 64 4 801 0493
www.massey.ac.nz

Information Sheet—Study Overview

Recognising emotions after brain injury

You are invited to take part in a research study. The study is with people who have had a brain injury. We are testing three treatments to help people with recognising emotions and help with thinking processes.

What does taking part involve?

Initial assessment

- 2.5 to 3 hours.
- Includes puzzles and activities to test thinking, and questions about your mood, things you do, and your relationships.
- We'd like to ask a family member or significant other to fill in a questionnaire.
- We'll let you know within three working days if you'll continue to treatment.

Further assessment

- Three weeks later, more tests.
- 2 hours.

Treatment

- Three times a week for three weeks.
- One hour each time.
- At our clinic in Wellington or a rehab service near you.
- One treatment focuses on studying pictures of faces.
  One treatment focuses on reading and answering questions from stories.
  One treatment focuses on "brain" games.
- All the treatments are done on a computer, with a therapist.

Follow-up

We will see you three more times after treatment.

- Four days after treatment.
- Three months after treatment.
- Six months after treatment.

In total, you may be involved for eight months.

How were people selected to take part in this study?

- Clients of the Psychology Clinic.
- Clients of other brain injury services.
- People who were included in a recent study we did.

You need to be:

- 16 to 65.
- Have had a moderate to severe brain injury, at least one year ago.
- There are other criteria such as being reasonably healthy, medically.

Are there any benefits or risks?

- You may improve your thinking and emotional processing.
- If you do not participate, you will still get your current treatment.
- We will partially reimburse your travel expenses for testing sessions.

What will happen to the information collected in the study?

- We will keep your information confidential, and use it only for this research.
- We would like your GP to tell us about your medication and any changes during the study and followup.
- Our research team includes people overseas—they will keep your information confidential too.

Taking part in this study is voluntary.

- It is your choice whether you participate.
- You can stop at any time.
- This will not affect your health care.

- You can talk to a family member.
- You can have a support person with you.
- You can ask any question you want to.

ACC

- If you had another injury when in this research, you may be covered by ACC.

Finding out about the results of the study.

We will send you the results of this study if you'd like us to.

Dr. Duncan Babbage telephone: 04 801 5799 ext. 62039
Psychology Clinic, Massey University, Private Box 756, Wellington

If you have any queries or concerns about your rights as a participant in this research study you can contact an independent health and disability advocate. This is a free service provided under the Health and Disability Commissioner Act.

Telephone: (NZ wide): 0800 555 050
Free Fax (NZ wide): 0800 2787 7678 (0800 2 SUPPORT)
Email (NZ wide): advocacy@hdc.org.nz

This study has received ethical approval from the Central Regional Ethics Committee which reviews National and Multi regional studies.

Jackki Yim
Doctoral Candidate

Duncan Babbage, PhD
Senior Lecturer, Clinic Director
New Zealand Principal Investigator

Appendix E: Information Sheet for Family Member

Massey University
WELLINGTON

PSYCHOLOGY CLINIC
24 King Street
Mt Cook
Private Box 756
Wellington 6140
New Zealand
T 64 4 801 0492
F 64 4 801 0493
www.massey.ac.nz

Information Sheet (Family Member)

Recognising emotions after brain injury

You are invited to take part in a study to determine the benefit of new therapeutic approaches for people with traumatic brain injury (TBI). You are being invited because you are a family member or caregiver of someone who is participating in this treatment study. The purpose of this study is to evaluate the effectiveness of three therapy programs to improve skills related to emotion and cognition in adults with TBI. We would like you to complete additional information about that person's everyday functioning, to assist us in understanding these issues better.

What does taking part involve?
If you accept this invitation, you are asked to fill out the enclosed questionnaire, which asks questions about your family member's physical, social, and emotional functioning. This should take you about 45 minutes. We will also ask you to complete the same questionnaire again prior to treatment starting, and three more times after the treatment sessions are completed (after five days, three months, and six months). Completing and returning these questionnaires indicates you consent to participate in this research project. If you decide not to participate, simply do not return the questionnaires.

How were people selected to take part in this study?
The study is being conducted as part of an international collaboration with colleagues in the United States and Canada. You may have been invited to participate because your family member has been a client of the Psychology Clinic at Massey University or another brain injury rehabilitation service, and has participated in this research project. Your family member may have been involved in a previous study that examined the prevalence of these issues and have indicated they would be happy to be contacted about this ongoing research programme.

To take part in this study you need to have a family member between 16 and 65 years old, who has had a moderate to severe traumatic brain injury at least one year ago, and who has participated in this study. Your family member must have adequate vision, hearing and communication abilities to be able to complete the task requirements. They must not be diagnosed with a mental illness other than depression. They must not be abusing alcohol or using an uncontrolled substance.

Are there any benefits or risks?
There is potential your family member will improve their skills related to cognition and emotional processing. The main benefit to you of taking part is the possibility that you will assist health practitioners to have a greater understanding of this problem after traumatic brain injury. The findings and treatments from this study will be made available to clinicians and consumers so that they can be incorporated into treatment approaches if they are found to be effective. The procedures used in the study have no known expected risks or harmful effects.

What will happen to the information collected in the study?
The things you say and the information we gather about your family member will be kept confidential and used for research purposes only. With consent we would contact your family member's GP to request updates regarding any medications they may be taking during the trial and the follow-up period that could affect their progress. No material that identifies you, or your family member will be used in any report on this project. We will store your family member's information in a secure location, and only those involved in

the research programme will be able to see it. This may include research collaborators at overseas sites who are part of this research project. They are equally commited to maintaining your privacy, and only anonymous information (information recorded without your name) would ever be transferred to another site. We will store your information for at least ten years after the end of the project, after which time our records will be securely destroyed.

Taking part in this study is voluntary.
It is your choice whether you take part or not. You do not have to take part in this study. If you decide not to take part, this will not affect your family member's continuing health care or rehabilitation. Please feel free to talk with a friend or family member if you need help to make the decision about whether to take part or not.

Compensation for Injury
In the unlikely event of a physical injury as a result of your participation in this study, you may be covered by the Accident Compensation Corporation (ACC) under the Injury Prevention, Rehabilitation and Compensation Act. ACC cover is not automatic and your case will need to be assessed by ACC according to the provisions of the 2002 Injury Prevention Rehabilitation and Compensation Act. If your claim is accepted by ACC, you still might not get any compensation. This depends on a number of factors such as whether you are an earner or non-earner. ACC usually provides only partial reimbursement of costs and expenses and there may be no lump sum compensation payable. There is no cover for mental injury unless it is a result of physical injury. If you have ACC cover, generally this will affect your right to sue the investigators.

If you have any questions about ACC, contact your nearest ACC office or the investigator.

Finding out about the results of the study.
If you would like to find out the results of the project, tick YES on the questionnaire. After the project is completed, we will mail you the results. There may be a long delay between when you take part and when results are known.

If you would like more information about the study, feel free to contact:

Dr. Duncan Babbage telephone: 04 801 5799 ext. 62039
Psychology Clinic, Massey University, Private Box 756, Wellington

If you have any queries or concerns about your rights as a participant in this research study you can contact an independent health and disability advocate. This is a free service provided under the Health and Disability Commissioner Act.

Telephone: (NZ wide): 0800 555 050
Free Fax (NZ wide): 0800 2787 7678 (0800 2 SUPPORT)
Email (NZ wide): advocacy@hdc.org.nz

This study has received ethical approval from the Multi-region Ethics Committee which reviews National and Multi regional studies.

Jackki Yim
Doctoral Candidate

Duncan Babbage, PhD
Senior Lecturer, Clinic Director
New Zealand Principal Investigator

Appendix F: Consent Form

Psychology Clinic
Private Box 756
Wellington
New Zealand
T 64 4 801 0492
F 64 4 801 0493
www.massey.ac.nz

Consent Form

Controlled Study of Affect Recognition Training for People with TBI

English	I wish to have an interpreter	Yes	No
Maori	E hiahia ana ahau ki tetahi kaiwhakamaori/kaiwhaka pakeha korero.	Ae	Kao
Cook Island	Ka inangaro au I tetai tangata uri reo.	Ae	Kare
Fijian	Au gadreva me dua e vakadewa vosa vei au.	Io	Sega
Niuean	Fia manako au ke fakaaoga e taha tagata fakahokohoko kupu.	E	Nakai
Samoan	Out e mana'o ia I ai se fa'amatala upu.	Ioe	Leai
Tokelaun	Ko au e fofou ki he tino ke fakaliliu te gagana Peletania ki no gagana o na motu o te Pahefika.	Ioe	Leai
Tongan	Oku ou fiema'u ha fakatonulea.	Io	Ikai

I have read and I understand the information sheet for volunteers taking part in this study. The nature and purpose of the study have been explained to me. I have had the opportunity to discuss this study and ask questions about it. I am satisfied with the answers I have been given. I have had the opportunity to use family/whanau support or a friend to help me ask questions and understand the study. I have had time to consider whether to take part.

I understand the following:

- Taking part in this study is voluntary (my choice). I may withdraw from the study at any time and this will in no way affect my continuing health care.
- I will be in control of what I do and what happens to me. I can ask questions or have a break when I need one.
- By participating I agree the clinical team may provide the researchers with information from my health care records regarding the nature and severity of my brain injury.
- My participation in this study is confidential and material which could identify me will not be used in any reports on this study.

I ______________________________ (full name)

hereby consent to take part in this study.

You may contact my family member/caregiver to invite them to fill in a questionnaire.
(Family member: ______________________) YES / NO

I would like to receive a copy of the results. YES / NO
Please send the results to (email or postal address): ______________

Signature:__________________ Date: __________

(There may be a long delay between when you take part and when the results are known).

I have had this project explained to me by__________________

Our postal address is: Psychology Clinic, Massey University, Private Box 756, Wellington.
If you would like more information about the study, please feel free to contact one of us:

- Jackki Yim telephone: 04 801 0492
- Dr. Duncan Babbage telephone: 04 801 5799 Ext. 62039

This study has received ethical approval from the Multi-region Ethics Committee which reviews National and Multi regional studies.

v1.0

Appendix G: Treatment Manual for *Faces* Intervention

Procedure Manual for

Facial Affect Recognition Intervention (FAR)

Dawn Neumann, Barbra Zupan, Barry Willer

Version: February 2009

FAR Intervention

Table of Contents

	Pages
I. Importance of Emotion Recognition	3-5
II. General Information (scheduling, scoring, logistics)	6
III. Treatment	7-17
1. Goals	7
2. Description of Program	7
a. Computer-Based Exercises	7-9
b. Advanced Emotional Training (Personal Emotions)	9-10
3. Administering the treatment	11
a. Course of treatment	11-12
b. Using the software	12-20
c. Helpful Hints/Strategies	21-27
d. Feature Descriptions	21-27
d. Problem Management	27-28
IV. Response Sheets	29-57
V. Using the Old Software	57

FAR Intervention

I. Importance of Emotion Recognition

Just like in the clinical setting, it's always good to reiterate the meaningfulness and importance of what you're working on with the participant and what you hope to accomplish. Some participants may not be aware they have a problem with affect recognition, or some may realize it, but not see the importance of it. In this study people will be asked to talk about emotionally personal events. They may not see the value of talking about their negative emotions. It's critical that you could help participants see the significance of learning to identify their negative emotions as well as understanding others' emotions.

<u>What we are working on and what we hope to accomplish</u>

"The purpose of this treatment is to try to help you better recognize how people are feeling. When this study is over, we hope that when you are talking or socializing with others, you will be better able to figure out how they are feeling."

<u>Why it's important to understand others' emotions</u>

- Help us to interact with others better (behavior)
  - If we know how people feel (spouse, friend, etc), it will help us to know how to respond to them. (sad= console; angry= apologize)
- Improve relationships
  - Develop emotional bonds. Understanding each others' emotions helps to develop a special kind of closeness in a relationship.
  - Help us to be a supportive friend, spouse, etc: We will be perceived as a supportive person if we anticipate others' emotional needs. This is a very important quality in a relationship. This is our way to repay somebody for all of

the care they have given to us. This will show our appreciation and affection.

- o Helps to show people we care about them. If we care about someone, we must care about that person's emotions. (ie. Did I hurt your feelings? Could I ease your sadness? Etc.)
- o Help us to become a person people want to interact with more. People appreciate if you understand their emotions and that you are concerned about their feelings. If we know someone cares about our feelings, we are more likely to want to spend time with them than someone who doesn't care.

Why it's important to discuss and understand emotions within ourselves

- Need to experience all of the emotions to get joy out of anything. Some people don't like to think about or experience negative emotions such as sadness or anger. Some people may say, "Life is too short to be bothered". But if you don't allow yourself to experience negative emotions, it's likely you won't have the full experience of "happy" either. Your system will get used to being emotionally shut down. We need to force ourselves to feel- good or bad.
- Emotional Control: Sometimes we let emotions build up because we ignore them and then we explode. If we dealt with them as they came, we wouldn't overreact at other times.
- Understand our emotions better. By thinking about and discussing negative emotions, we may better figure out how we are truly feeling and why. Sometimes our emotions aren't always what they seem initially. Sometimes we react angry when we are really sad. We would probably have a much better outcome if we communicated sadness to someone instead of always acting angry. Also, if something caused us to feel badly we could learn to avoid what caused the feeling in the future, or communicate this to others.
- Understand others better. If we understand our own emotions, we will better relate to others and know when they are feeling a certain way. How do we want people to respond to us when we are feeling bad? Then we could respond that way to others when we see they are feeling bad.

FAR Intervention

- Help to us to communicate our needs better with others so they know what we're experiencing and how to help us. This could avoid misunderstandings and unnecessary arguments.
- Be more productive: Emotions are a motivator. If we feel passionate about something we will work on it and complete it. On the other hand, sometimes we may be expected to do something we really don't want to. If we don't do it, we will get in trouble. If we want to avoid feeling bad- we will get it done because we don't want the negative consequences (which will make us feel bad).
- Have better judgment and decision-making: If we know our actions and behavior may hurt someone we may decide not to do it, because we know how it feels. Or if our actions or behaviors may get us in trouble (ie. yelled at, making us feel bad) we will avoid those behaviors.
- Improve memory: The more emotionally connected we are to things, the better we will remember them.

FAR Intervention

II. General Information

Schedule: Training needs to be 3 times a week for 3 weeks, and hour each session. Try to schedule appointments 1 week at a time (or more if possible), rather than 1 day at a time.

	Sun	Mon	Tues	Wed	Thurs	Fri	Sat
Week 1							
Week 2							
Week 3							

Clients/Participants may often finish more than one training exercise in one session. In order for the client to move on to the next training level, he or she must achieve 85% accuracy for that exercise. Therefore, the client/participant must repeat any exercise that they fail. They only have 2 tries to reach 85%, so if on the second try the client/participant does not reach 85%, then just move on to the next exercise. If the client/participant is below 85% accuracy for an exercise and there is a lot of time remaining in that session, you may move on to the next training exercise for that day. However, on the following training day you must start with and repeat the level that the client/participant failed.

Training will be 1 on 1, in a quiet room. You will need a computer and internet service. Provide breaks to the participant as needed, but do try to manage your time efficiently. This could sometimes be a challenge since many participants will like to talk a lot or go off on tangents. If this is the case, set aside break time and/or at the end of the session for general chat time. It is important to do the small talk because you need to develop a rapport with the patient. The better the rapport, the more willing they will be to open up emotionally to you.

FAR Intervention

III. Treatment Program

1. Goals: FAR aims to improve two main skills that are theorized to be the crux of how emotions are recognized in others. According to the literature, the two main ways in which we determine emotion in others is by: a) attending to and understanding important emotional cues and 2) having experienced that emotion ourselves; therefore referring to our own similar emotional experiences. Consequently the goals of this treatment program are:

i. To teach participants to attend to facial features/regions that are most important for determining emotion (eye region: brows and lids; and mouth)

ii. To use personal emotional experience to relate to and identify emotions in others.

2. Description of the Program:

There are two main components to this program. One component uses a computer to familiarize participants with facial expressions. The other piece uses elaborate discussion to help the participant relate to the emotions being discussed, through awareness of their own personal emotional experiences. Both components of this program are interwoven and require a lot of interaction between the participant and the therapist.

a. Computer-Based Exercises

- There are 7 Levels of computer-based exercises. There are several parts (or activities) within each of the 7 exercises. Directions are provided at the beginning of each activity. Activities may include the following tasks:
  i. Identify the emotion being expressed. *Draw the participants' attention to important facial features and describe them.*
  ii. Identify the emotion being expressed *and* discuss a personal experience that made you feel the emotion just identified. *You will discuss the personal experience for a few minutes to get some basic information about the event. Personal emotional experiences will be discussed at greater length after that computer exercise is completed.*

FAR Intervention

iii. Identify the emotion being expressed *and* Imitate the emotion being expressed. *After identifying the emotion, imitate the expression in the mirror. Provide guidance to the participant while they are trying to mimic the facial expression, such as "scrunch your eyebrows more; put more tension in your face". If the mirror makes them laugh, don't make them use it initially. You could make the face with them. You could also remind them of their personal emotional experiences to try to evoke the actual emotion, authenticating the facial expression).*

iv. Identify the emotion being expressed; and Discuss a personal experience that made you feel the emotion just identified; and Imitate the emotion being expressed

v. Face Similarities: *The participant will have to identify the similar characteristics among several faces that are all depicting the same emotion.* (Note: explanation of this was accidentally cut off on Training DVD)

vi. Face Selection: *The participant will be asked to find the face that expresses a particular emotion from several faces depicting different emotions.* (Note: explanation of this was accidentally cut off on Training DVD)

vii. Advanced Emotional Processing: You will discuss in detail, some of the personal experiences the person mentioned as causing them to feel a particular emotion. The record sheets will guide you to know which events to discuss.

- Throughout the computer-based exercises, there are 40 faces that are frequently repeated throughout the training exercises. The faces vary in gender, ethnicity and intensity of expression (subtle vs obvious). Faces that are more obvious are presented first. As the participant gets further along in the program, the expressions are more subtle to present more of a challenge.
- Strategies in the program (discussed in detail later):
  i. Vanishing cues: arrows and verbal descriptions are used to draw participant's attention to the important facial features. The cues gradually vanish over the course of the program to help the person become more independent at attending to these features.
  ii. Feedback: If person is incorrect in their selection of what emotion is being expressed they will receive 2 forms of feedback. First, the participant will be told to try again. Secondly, they will be presented with a detailed description of the feature characteristics (ie. eyes are wide open), along with the correct answer. If the participant made the correct choice, you will ask them how they knew, requiring them to describe the features. A description of features is presented later that you could use to cue them. Make sure to be consistent with the

descriptions you use about the features (consistency and repetition is important).

- Recording Responses and Scoring: In order for the client to move on to the next training level, he or she must achieve 85% accuracy for that exercise. Therefore, the client/participant must repeat any exercise that they fail. They only have 2 tries to reach 85%, so if on the second try the client/participant does not reach 85%, then just move on to the next exercise. If the client/participant is below 85% accuracy for an exercise and there is a lot of time remaining in that session, you may move on to the next task for that day. However, on the following training day you must start with and repeat the exercise that the client/participant failed. See example of Treatment course on pg xx.

b. Advanced Emotional Training (Personal Emotions)

- Activity: Discuss in detail some of the personal events that the participant mentioned during the computer-based exercises. There are 2 purposes to this section: a) to help the participant better understand what others are feeling, by first better understanding their own emotions; b) have them get in touch with the physiological changes and changes in their body state that are associated with particular emotions.
- The main ideas: to have the person know 1) how an event made them feel, 2) why it made them feel that way, 3) how their emotions made them behave or react, 4) and how were others affected by the event itself and the person's emotional reactions. There is a guideline of questions that should be used for this that are listed below as well as on the response sheet. However, this guideline can be varied somewhat to fit the event being discussed. Feel free to ask additional questions to get more feedback from the participant. Also, if the question is not appropriate for the event being discussed, you may skip it or alter it so that it is more appropriate. As you are having the discussion with the participant, do not let them go too far off on a tangent. Keep them focused on the task at hand. However, if the conversation is productive, you have the time, and you are addressing the key goals (stated above), you could continue the discussion. Conversations should usually last around 15 to 20 minutes *(This is not very evident from the training DVD due to time constraints)*. If you are talking about a negative emotion, always end with a positive outcome from that event.
- Sample of General Discussion guideline*: (See response sheets for detailed questions for each specific emotions)*

FAR Intervention

"The other day we discussed ….(event listed above)". I would like to spend more time discussing that event. So let's start off by talking more about it.

a) Try to describe the event to me in detail (ie. when was it, where was it, who was there, etc)
b) What led up to the event?
c) How did the event make you feel? You may have felt several different emotions. What was the strongest emotion you felt? _________ (should be happy)
a. Describe how that made you feel inside (heart rate, muscle tension)? What feelings are usually associated with "happiness"? _______ *Help the participant out if need be by using the following examples.* Very often when we are happy we feel like we are floating in air or on water. Our muscles are relaxed. Our heart rate is low and normal. We might feel tingly inside. Try to generate that feeling of happiness as you think about the event.
b. Did this event make you feel any other emotion? If yes, describe.______________
d) Why do you think you felt the emotion(s) you did?
e) What were the consequences/outcome of the event?
f) How did you respond to the event or what was your reaction or how did you act (whatever is appropriate for the event being discussed)
g) How do you think others who were involved felt and why?

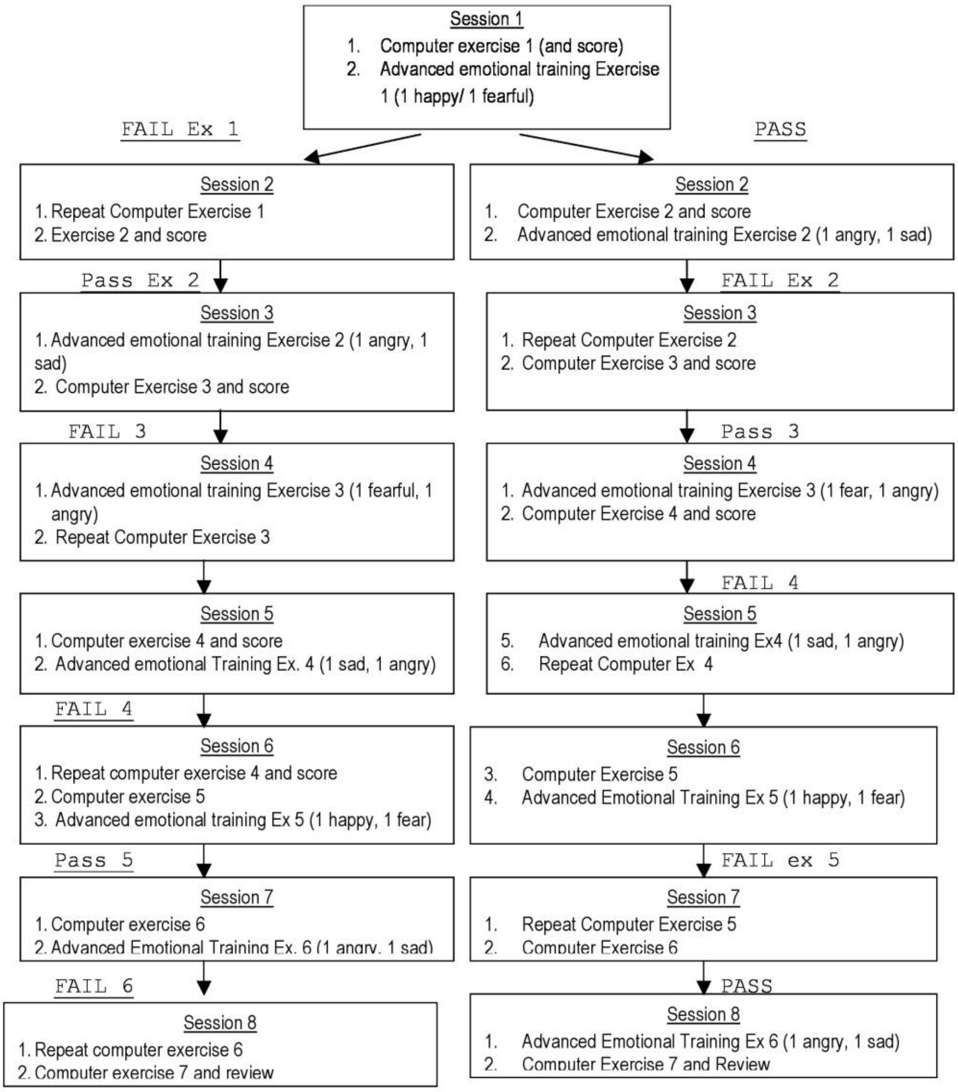
- Description of typical body state/ physiological changes associated with the different emotions. As you are discussing events and emotions with the participants, use the descriptions provided below to illustrate how certain emotions "feel".
  - Happy: swelling feeling in chest; muscles relaxed; sensation of buoyancy or lightness as if standing underwater.
  - Sad: heaviness in chest, arms and legs; tightness in throat and eyes. Eyelids knitted, lids lowered, corners of mouth downward.
  - Anger: Increased muscle tension in neck, shoulders, arms, legs; increased heart rate. Eyebrows scrunched, teeth/ jaw line clenched due to overall increase in tension.
  - Fear: Increased muscle tension **or** muscles become weak/ jello/rubbery. Heart races. May become jumpy or jittery. Butterflies in stomach. Eyes wide open. Eyebrows raised, jaw slack.
- When discussing the personal events, put the display of 8 faces up on the computer (2 faces expressing each emotion). After discussing the event, have the person point to which face best depicts the emotion they were feeling as a result of the event.

FAR Intervention

- At the very end of training and all of advanced emotional training has been completed, repeat the Computer-based Exercise Review (Exercise 7)

3. Administering the Treatment: ***Note:** ***Different from video!!!!***

A) Example of Potential Treatment Course **(This is correct version)**



11

FAR Intervention

Pass 7

Session 9
1. Advanced emotional training Ex 7 (1 happy, 1 sad)
2. Repeat review from Ex 7

Session 9
1. Advanced Emotional Training Ex 7 (1 happy, 1 sad)
2. Repeat Review from Ex 7

of Emotional Training from the day before and didn't finish, complete it at the beginning of the following session.

- If you are running short on time, you could:
    - Decrease the amount of time you spend talking about the personal emotional experiences.
    - Or only discuss (advanced training) 1 of the emotional experiences specified in detail
- If you have too much time, you could:
    - Increase the amount of time you spend talking about personal emotional experiences.

B) <u>Using the Software for FAR (Program 1)</u>

<u>Working Through the FAR Treatment Program</u>

<u>* Before beginning the program, state:</u> "The purpose of this treatment is to try to help you better recognize how people are feeling. When this study is over, we hope that when you are talking or socializing with others, you will be better able to figure out how they are feeling."

1. **Open IMOLE software.**
When you open the program, you will see:
Program 1
Program 2
Program 1 refers to FAR and Program 2 refers to SEI.

-------*Insert pic here*----------

2. **Click <u>once</u> on "Program 1"**
The FAR program contains 7 "Levels" of exercises. You will see listed, "FAR Procedures, FAR Level 1-7". You will also see, "Demonstration of emotion Comparisons", "Faces to Demonstrate how I felt" and "FAR Procedures". These are not activities, rather tools that should be used to assist learning during the activities. More information about these sections later.

------ *Insert pic here*----------

3. **Click <u>once</u> on the "FAR Level" you are working on (ie. FAR Level 1).**

FAR Intervention

Each "Level" within the FAR program contains multiple sections and exercises to be completed in the following order: 1) "Sections" (Start with section 1 and work your way through. The number of sections will vary in each Level); 2) "Reviews" (in all levels except Level 1); 3)"Face Similarity"; 4)"Face Selection"; 5) Advanced Emotional Processing.

You will see listed….

------ *Insert pic here*----------

4. **Click <u>once</u> on "FAR Level 1, Section 1"**
The first page of every section provides you with directions for the section you are in:
"In this section you will see faces expression different emotions. Your task is to identify the emotion each face is expressing."
Read through these directions with the participant.

5. **Go to the bottom of the page and click the forward arrow (→).**
This will bring you to the first page of Level 1, Section 1's exercise. Here you will see a face, and the participant is asked, "How does this person feel?". You should read this question out loud to the participant or even rephrase and say, "how do you think this person feels?" As you could see, there are cues telling the participant what features to pay attention to (ie. The yellow arrows and verbal instructions tell the person to look at the eyes and the mouth). These cues will vanish over time as the program progresses. If possible, before the participant answers, ask them what features of the face they think they are supposed to be paying attention to. If they don't know, draw their attention to these cues and explain to them that the most important cues for emotion are in the eye region (brows and eyelids) and the mouth.

------ *Insert pic here*----------

Once the participant makes their choice, you will click the response for them.
<u>If the participant guesses right</u>, ask them how they knew the person was feeling that particular emotion. They may say "I don't know", "they just look that way", or "because of the eyes and mouth". This is not enough. Have them try to describe the characteristics of the eyebrows, eyelids and mouth. Say, "What is going on with the eyebrows that makes him/her look _____. Refer to the list of Facial Feature Feedback in the section on "Helpful hints/strategies/Feature Descriptions" on Pg.22, 23-27 for assistance. If the participant could come up their own description that's great, but most often they will have a difficult time, so you will have to give them the words

to describe the features. Refer to this list of feature descriptions and be consistent with using the same words throughout the program. Once you are finished with this discussion, you will hit the **forward arrow (→)** at the bottom of the page which will bring you to the next page in that exercise. Continue to go through all of the pages in that section until you get to the end and it brings you to the next section. Although the program will be recording the responses, you should also record the responses as well on your response sheet.
If the participant guesses wrong, a pop-up message will come up saying, "No this person is not ________. Study the hints to the right of the picture."

------ *Insert pic here*----------

In addition, a "hint" box will appear with more detailed descriptions about each of the relevant features (ie. Eyebrows are raised and eyes are wide open."

------ *Insert pic here*----------

Reviewing the feedback: Draw the participant's attention to this and have them read it out loud or read it out loud for them. Stop after reading each sentence and bring their attention back to the picture asking them if they see what is meant by the description (ie. Do you see how the eyebrows are raised and the eyes are wide open? Do you see how that makes this person looks fearful? Why would someone who is fearful have their eyes wide open? To better assess the situation.) After reading the description for each feature, it will provide the correct response. So ask them again, "Now that we've discussed it, tell me how this person feels." Now, you will record the person's initial incorrect response and mark them wrong, even though they eventually tell you the correct response. After selecting the correct response, hit the **forward arrow (→)** at the bottom of the page.

Theory behind feedback presentation and how to present it: The reason the feedback combines eyebrows and eyes in one sentence, is because the features together make the person fearful. The eyes alone being wide open, would probably not mean the person is fearful. Alone, wide open eyes might also mean angry. The fact that the wide open eyes are accompanied with completely raised eyebrows means the person is fearful. In addition, although the features are described separately as eyes, then mouth, we want to encourage the person to see the face as a whole. So, look at the features first, then the face as a whole. Does the face as a whole look negative or positive. If positive→ Happy. If negative, is there high energy? High negative energy would suggest either angry or fearful. Low negative energy would suggest sad. Thinking of the face this way could help the person to narrow down the possible correct response through process of elimination.

Confusing 2 emotions <->: If the participant seems to be continually confusing 2 emotions, you will use the <-> key at the bottom of the page. This will bring you to the section on "Demonstration of emotion Comparisons". You will select whichever pair of emotions the participant is confusing. The combinations include: sad vs angry (3); angry vs fearful and (2); Sad vs Fearful (2). When comparing the faces, you should start from the top of the faces, contrasting the features and work your way down. For example in the Sad vs Angry comparison, "Look at the eyebrows. How do they look on the girl on the left? How does this differ from the girl on the right? What about the eyes,…. Mouth…. What impression do you get when you look at the entire face? The girl on the left looks droopy (low, negative energy. The girl on the right, her face is tense (high negative energy. After viewing 1 face comparison, you could either go directly back to the section you were working on by hitting the <-> key at the bottom. Or, if you want to view another pair of faces to compare, hit the <- arrow key to get to the comparison menu, or hit the -> to automatically go to the next set of faces. Note this section is not required for training, but it is highly encouraged this strategy be used.

***6.* End of FAR Level 1, Section 1**

When you get to the end of FAR Level 1, Section 1, it will either automatically take you to the next section (FAR Level 1, Section 2) by hitting the **forward arrow (→)** at the bottom of the page, or you could use the "Chapter" button at the bottom of the page. This will take you back to the page that lists all of the activities in this level. At that point you would click once on **FAR Level 1, Section 2**

7. FAR Level 1, Section 2

The first page of section 2 will present you with directions: *"In this section after you identify the emotion for each face, I will ask you to discuss a time you remember feeling that emotion yourself or an example of an event that would make you feel that emotion".* Read through these directions with the participant.

------ *Insert pic here----------*

Follow instructions from # 5. Plus…..

After identifying the emotion, if you hit the -> key at the bottom of the page, it will bring you to the next page that explicitly reminds you to now have the person to tell you something that happened to them in their life that made them feel that emotion. You should give them some time to think about this. Don't expect a response too

FAR Intervention

quickly. If after you give them some time and they still can't generate anything, try to stimulate some ideas. Present them with topics, "how about something with your Mom and Dad, or something with your spouse, or something that happened to you in school or work, etc. Refer to topics that were given by the person's informant when they completed their questionnaires. If the person is still an emotional person with an ok memory, refer to current things that make them emotional. If they lack a lot of affect and/or have poor memory, refer to things prior to the injury.
Try not to let them repeat the same event in the same day. If it is a new day (different session) give them a little slack if it is really difficult for them to come up with an example.

This time the cues drawing attention to the eyes and mouth will be reduced. All of the directions are the same. For FAR Level 1, when you get to the end of Section 2, you will still have to go to section 3. This will NOT be the case for Levels 2, 5, 6, or 7. For those Levels there is no Section 3, therefore you will go straight to the **Review Section** (Skip to number 9 in these instructions).

8. **FAR Level 1, Section 3**
The first page of section 3 will present you with directions:
"In this section after you identify the emotion for each face, you will be given a mirror and asked to imitate that emotion".
Read through these directions with the participant.

------ *Insert pic here----------*

Follow instructions #5, plus...
After they identified the emotion hit the -> key at the bottom of the page. It will bring you to the next page that explicitly reminds you to now have the person imitate the emotion they just identified using a mirror. Give them hints to help improve their expression to make it look more like the picture. Tell them what to do with their eyebrows, eyelids, mouth. Another way to get a more "genuine" expression out of them would be to remind them of an emotional event they just told you that made them feel the emotion they are trying to mimic. You could also imitate the facial expression along with them so they don't feel silly. If they are doing it wrong, imitate their wrong expression and ask them if it looks like the expression on the computer and why it doesn't.

For FAR Level 1, when you get to the end of Section 3, you will go directly to **Face Similarity** because there is no review for Level 1. You will get to this section either by hitting the **forward arrow (→)** at the bottom of the page, or you could use the "Chapter" button at the bottom of the page. This will take you back to the page that

FAR Intervention

lists all of the activities in this level. At that point you would click once on **FAR Level 1, Face Similarity.** Skip to # 10 in the instructions. It should be noted that for all other Levels (2-7) you will go directly to the Review (#9). You will get to the review section either by hitting the **forward arrow (→)** at the bottom of the page, or you could use the "Chapter" button at the bottom of the page. This will take you back to the page that lists all of the activities in this level. At that point you would click once on **FAR Level X, Review.**

***9.* Review**

The first page of the Review will present you with directions:
"Now you will review faces that you have learned so far up to this point of the program. Your task is to identify the emotion that each face is portraying. In this section after you identify the emotion for each face, you will be given a mirror and asked to imitate that emotion".
Read through these directions with the participant and hit the **forward arrow (→)** at the bottom of the page. Go through the page following #5's instructions.

***10.* Face Similarity**

- In this section, you will first be presented with the directions, which state, "Next you will see faces on the screen that are all expressing the same emotion. Even though they are different faces, their expressions look similar. That is how we know they are feeling the same emotion. You will be asked questions about how the features of their face look similar."
- Read through these directions with the participant and hit the **forward arrow (→)** at the bottom of the page.
- Pictures will be presented across the top of the page. Below that will be a box to the left that lists the important features for those faces. Some pages will just have one (ie. Mouth). Other pages will have multiple features (eyebrows, eyes, mouth). You will click on 1 at a time (starting from top to bottom-eyebrows first). In a box to the right, a question will appear about the similarity of the feature across the different faces. Below the question will be response options. The participant will be told to choose the response that is the most accurate. Although certain answers are more correct than others, these responses have never been tested/standardized. Consequently, this section is NOT scored.

------ *Insert pic here*----------

- When you get to the end of this section, you will go to **Face Selection.** You will get there by hitting the **forward arrow (→)**

at the bottom of the page, or you could use the "Chapter" button at the bottom of the page. This will take you back to the page that lists all of the activities in this level. At that point you would click once on **Face Selection.**

***11.* Face Selection**

- Read the instructions with the participant, which are "You will now be shown 4 faces on the computer. You will be asked to select which face is expressing a particular emotion. For example, you will be asked to identify which face looks 'sad'. Hit the **forward arrow (→)** at the bottom of the page to begin this section.
- Participants are shown multiple faces and are asked to select the face that is portraying a particular emotion. Have the participant respond and discuss their response with them: why it was right or wrong.

------ *Insert pic here*----------

***12.* Advanced Emotional Processing**

- This is the part where you will discuss in detail the personal experiences that participants brought up earlier (see #14 below). As you are discussing the participants' personal events, you will be sitting face to face with them, having less interaction with the computer. However, during the discussion, you will have 8 faces displayed on the computer (2 of each emotion, 1 that is mild and other strong). You will display this page by hitting the <-> at the bottom of the page. You could return to the chapter from there (at the bottom left hand corner) or to where you left off in the program by hitting the <-> button at the bottom of the page again.

***13.* Scoring.**

The computer collects data as each response is entered and will automatically generate a score when that level is complete. This score will tell you how many the person had right and what their percentage was. As discussed earlier, the participant needs to get 85% or better to begin the next Level of the computer exercises. Refer to Potential Treatment Course on Pg 11. No matter what the person's score (Pass or not) you will go to the Advanced Emotional training for the level they just completed. After the Advanced Emotional training, if they failed, you will repeat the Level if they (without the advanced emotional training afterwards). If they passed, go to the next level.

***14.* Advanced Emotional Training for Level 1:**

FAR Intervention

Before continuing with the next Level of the computer exercise, you will engage in the Advanced Emotional Training for that level. This is primarily not computer driven, but by questions that are specific to the personal events that the person just discussed in the level that was just completed (ie. Level 1). The questions presented below are meant to be used as a guide and should be altered as appropriate. The purpose of this part of the exercise is to help the person better understand his/her own emotions so that they could relate better to others' emotions. When discussing the event, do not tell them outright you are discussing a "happy" event, and so on. They will answer how the event made them feel as you get into discussion. Feel free to ask additional questions to get more feedback from the participant. Also, if the question is not appropriate for the event being discussed, you may skip it or alter it so that it is more appropriate. As you are having the discussion with the participant, do not let them go too far off on a tangent. Keep them focused on the task at hand. If you are talking about a negative emotion, always end with a positive outcome from that event.

Instructions: "Now we are going to do something a little different from looking at faces on the computer. We are going to spend a little more time discussing some of the personal events you brought up when we were doing the computer exercise. This part of the training is very important for helping you to understand your own emotions, which in turn is important for understanding how others are feeling. When we are discussing these things that happened, I want you to try to put yourself back into the situation. I want you to recall it as vividly as possible and try to feel what you 'felt' at the time of the event. What I mean by 'felt' is that there are cues that our body gives us to let us know how we are feeling. For example, if we are angry, our bodies get tense and our heart-rate increases. If we are sad, our bodies feel heavy. I want you to try to 'feel' these type of feelings again. "

Advanced Emotional Training from Computer Exercise 1

Event: (HAPPY) ____

"Earlier we discussed ….(event listed above)". Let's spend more time talking about that.

a) Try to describe the event to me in detail (ie. when was it, where was it, who was there, etc)What led up to the event?

FAR Intervention

b) How did the event make you feel? You may have felt several different emotions. What was the strongest emotion you felt? _________ (should be happy)
   b. Describe how that made you feel inside (heart rate, muscle tension)? What feelings are usually associated with "happiness"? _______ *Help the participant out if need be by using the following examples.* Very often when we are happy we feel like we are floating in air or on water. Our muscles are relaxed. Our heart rate is low and normal. We might feel tingly inside. Try to generate that feeling of happiness as you think about the event.
   c. Did this event make you feel any other emotion? If yes, describe.______________
c) Why do you think you felt the emotion(s) you did?
d) What were the consequences/outcome of the event?
e) How did you respond to the event or what was your reaction or how did you act (whatever is appropriate for the event being discussed)
f) How do you think others who were involved felt and why?

Event: (FEARFUL) ____

"Another thing we talked about was..(listed above). Let's spend more time discussing this."

a) Try to describe the event to me in detail (ie. when was it, where was it, who was there, etc)
b) What led up to the event?
c) How did the event make you feel? What was the strongest emotion you felt? _________ (should be fearful, but if not, go with it)
   a. Describe how that made you feel inside (heart rate, muscle tension)? What feelings are usually associated with "fearful"? _______ *Help the participant out if need be by using the following examples.* Very often when we are afraid, our heart rate speeds up, our stomach may have butterflies, we might start to sweat and shake. We may feel on edge or jumpy. Try to generate that feeling of fear as you think about the event.
   b. Did this event make you feel any other emotion? If yes, describe.______________
d) Why do you think you felt the emotion(s) you did?
e) What were the consequences/outcome of the event?
f) How did you respond to the event or what was your reaction or how did you act (whatever is appropriate for the event being discussed)
g) How do you think others who were involved felt and why? How do you think your reactions made others feel (if appropriate question for the situation)?
h) Tell me something good that came out of that event (ie. something you learned etc)

FAR Intervention

1. **Return to computer exercises**

Once you finish the Advanced Emotional Training, go back to the computer exercises starting at the Level where you left off and repeat the instructions.

C) Helpful Hints/Strategies/Feature Description

i. Hints:

- Before staring, always make sure the participant knows why it is so important to understand other's emotions.
- Features→ Whole Face→ What happened to this person?
- Eyes, Eyes, Eyes!! (Cover mouth)
- Confusing 2 emotions: ie. Angry vs Sad (Emotional Comparison Demontration)
- Words to describe features for each emotion (see *iii Feature Description* below)

ii. Strategies:

Strategies incorporated in the program:

- Identifying the emotion
- Visual cues (vanishing)
- Descriptive feedback= describe characteristics of facial features
- Discussing a personal event that made them feel the emotion they just identified
- Imitating the facial expression they just identified.
- Understanding similarities of an emotion (sad) expressed in different faces (features look similar)
- Identify face with particular emotion (Discriminating emotions)

Strategies not embedded into the program:

- **Whole face vs. Individual features.** First we emphasize individual features, especially the eyes. Then we encourage the person to look at the whole face. What does it look like might have just happened to this person? Something good or bad? Theory behind feedback presentation and how to present it: The reason the feedback combines eyebrows and eyes in one sentence, is because the features together make the person fearful. The eyes alone being wide open, would probably not mean the person is fearful. Alone, wide open eyes might also mean angry. The fact that the wide open eyes are accompanied with completely raised eyebrows means the person is fearful. In addition, although the features are described separately as

FAR Intervention

eyes, then mouth, we want to encourage the person to see the face as a whole. So, look at the features first, then the face as a whole. Does the face as a whole look negative or positive. If positive→ Happy. If negative, is there high energy? High negative energy would suggest either angry or fearful. Low negative energy would suggest sad. Thinking of the face this way could help the person to narrow down the possible correct response through process of elimination.

- **Only focusing on the mouth.** Some participants may only focus on the mouth and will tend to ignore the eyes. If this is the case, take your hand and cover the mouth region, forcing the person to look at the eye region. Stress the importance of this area.

- **Confusing 2 emotions:** Very often participants confuse Anger and Sadness with one another. Must focus on the difference in features (angry faces are tense vs sad faces are droopy, etc). In order to work on this go to the "Demonstration of Emotion Comparison" section that compares faces expressing different emotions. Also focus on different sources of these emotions. Why something would make someone sad versus angry and how "sad" feels vs how "angry" feels.

- **Generating personal emotional events for discussion:**
  - Use participant likes/ dislikes to help them generate discussion of personal, meaningful events.
  - Think about things that caused the person to experience emotions before injury: family (parents/kids), relationships, work, hobbies, sports, etc
  - Use examples from informant/caregiver to generate ideas of emotional events.

iii. Feature Description:

General Feature Descriptions by emotion:

Happy: Overall impression is relaxation
Eyebrows: Relaxed
Eyes: Relaxed, lids covering some of the eye
Mouth: Curved up, corners of lips starting to curve up.

FAR Intervention

Sad: Overall impression is weighed down like wearing a weighted vest, droopy, sagging

Eyebrows: Eyebrows knitted together; angled up in the middle and angled down on the outside;
Eyes: Lids often lowered, covering some of eye; look heavy
Mouth: curved down, especially corners of lips; sometimes pouting; lower lip may jut out, creating dimple in chin

Angry: Overall impression is tension/tightness; sometimes exposing teeth (especially lower teeth)

Eyebrows: Scrunched together; angled down in the middle, up on outside (opposite of sad)
Eyes: Lids open; appearance of glaring
Mouth: Jaw and lips are tense, sometimes gritting or exposing teeth

Fearful: Overall impression is everything open to take everything in

Eyebrows: Raised
Eyes: Wide open; see a lot of whites in the eyes*
Mouth: Slack as if lower jaw dropped. Sometimes mouth wide open, sometimes not.

*Stress that fear is mostly seen in the eyes. Try covering mouth several times to demonstrate.
**Sometimes Fear will be confused with surprise even though surprise is not an option. In the training folder, there is a powerpoint presentation labeled emotvsemot. It contrasts several emotions with one another by placing them side by side. By seeing fear and surprised faces next to one another, you can discuss the distinctions.
***Sometimes Sad and Angry can be confused. Use the emotvsemot power point to demonstrate the differences ie. droopy vs tense; eyebrow direction.

Facial Feature Feedback

By order of presentation in each Level (Section 1 only):

Level 1:

1) Fearful 102:
    - Eyebrows are raised and Eyes are wide open.
    - Jaw dropped. Mouth is slack.
    - Overall: No tension. Face appears Open.
2) Happy 206:
    - Eyes are relaxed

FAR Intervention

- Lips are curved up.
- Overall: Relaxed

3) Sad 112:
   - Eyebrows are knitted together (angled up in the middle) / \ and Eyelids are droopy.
   - Lips are starting to pull down at the corners.
   - Overall: Droopy
4) Happy 131
   - Eyes are relaxed
   - Lips are curved up.
   - Overall: Relaxed
5) Angry 129:
   - Eyebrows are scrunched together (angled down in the middle) \ / and Eyes are glaring.
   - Mouth is tense and teeth are clenched.
   - Overall: Tension
6) Fearful 132:
   - Eyebrows are raised and Eyes are wide open
   - Jaw dropped and Mouth is slack.
   - Overall: No tension. Face appears Open.
7) Angry 101
   - Eyebrows are scrunched together (angled down in the middle) \ / and Eyes are glaring.
   - Jaw is tense. Lower teeth are exposed.
   - Overall: Tension
8) Fearful 236
   - Eyebrows are raised. Eyes are wide open.
   - Jaw dropped and Mouth is slack.
   - Overall: No tension. Face appears Open.
9) Sad 117
   - Eyebrows are slightly knitted together (angled up in the middle) / \ and Eyelids are droopy.
   - Lips are starting to curve down.
   - Overall: Droopy

<u>Level 2</u>:

1) Happy 152:
   - Eyes are relaxed
   - Lips are curved up
   - Overall: Relaxed
2) Angry 128:
   - Eyebrows are scrunched together (angled down in the middle) \ / and Eyes are glaring.
   - Jaw is tense. Lower teeth are exposed
   - Overall: Tension
3) Sad 219:
   - Eyebrows are knitted together (angled up in the middle) / \ and Eyelids are droopy.
   - Lips are starting to pull down at the corners.
   - Overall: Droopy
4) Happy 227:
   - Eyes are relaxed

FAR Intervention

- Lips are curved up
- Overall: Relaxed

5) Fearful 18:
   - Eyebrows are raised. Eyes are wide open.
   - Jaw dropped and Mouth is slack.
   - Overall: No tension. Face appears Open.
6) Fearful 29:
   - Eyebrows are raised. Eyes are wide open.
   - Jaw dropped and Mouth is slack.
   - Overall: No tension. Face appears Open.
7) Angry 23:
   - Eyebrows are scrunched together (angled down in the middle) \ / and Eyes are glaring.
   - Jaw is tense. Lower teeth are exposed
   - Overall: Tension
8) Sad 232:
   - Eyebrows are knitted together (angled up in the middle) / \ and Eyelids are droopy.
   - Lips are starting to pull down at the corners.
   - Overall: Droopy
9) Fearful 50:
   - Eyebrows are raised. Eyes are wide open.
   - Jaw dropped and Mouth is slack.
   - Overall: No tension. Face appears Open.

Level 3:

1) Angry 201:
   - Eyebrows are scrunched together (angled down in the middle) \ / and Eyes are glaring.
   - Mouth is tense and lips are pulled tight in a flat line.
   - Overall: Tension
2) Sad 108:
   - Eyebrows and lids are pulled down.
   - Lips are starting to pull down in the corners.
   - Overall: Droopy
3) Fearful 137:
   - Eyebrows are raised. Eyes are wide open.
   - Jaw dropped and Mouth is slack.
   - Overall: No tension. Face appears Open.
4) Angry 25:
   - Eyebrows are scrunched together (angled down in the middle) \ / and Eyes are glaring.
   - Lips are pulled tight in a flat line.
   - Overall: Tension
5) Happy 140:
   - Eyes are relaxed
   - Lips are curved up
   - Overall: Relaxed

Level 4:

FAR Intervention

1) Angry 43:
    - Eyebrows are scrunched together (angled down in the middle) \ / and Eyes are glaring.
    - Mouth is tense and lips are pulled back
    - Overall: Tension
2) Fear 130:
    - Eyebrows are raised. Eyes are wide open.
    - Jaw dropped and Mouth is slack.
    - Overall: No tension. Face appears Open.
3) Angry 233:
    - Eyes are glaring.
    - Lips are pulled tight in a flat line.
    - Overall: Tensio
4) Sad 107:
    - Eyebrows are knitted together (angled up in the middle) / \ and Eyelids are droopy.
    - Lips are starting to pull down at the corners.
    - Overall: Droopy
5) Happy 19:
    - Eyes are relaxed
    - Lips are curved up
    - Overall: Relaxed

Level 5:

1) Fearful 153:
    - Eyebrows are raised. Eyes are wide open.
    - Jaw dropped and Mouth is slack.
    - Overall: No tension. Face appears Open.
2) Sad 147:
    - Eyelids are droopy.
    - Lips are starting to pull down at the corners.
    - Overall: Droopy
3) Happy 224:
    - Eyes are relaxed
    - Lips are curved up
    - Overall: Relaxed
4) Angry 45:
    - Eyebrows are scrunched together (angled down in the middle) \ / and Eyes are glaring.
    - Mouth is tense and lips are pulled tight in a flat line.
    - Overall: Tension
5) Sad 231:
    - Eyebrows are knitted together (angled up in the middle) / \ and Eyelids are droopy.
    - Lips are starting to pull down at the corners.
    - Overall: Droopy

Level 6:

1) Sad 215:
    - Lips are starting to pull down at the corners.

FAR Intervention

- Overall: No tension, Droopy

2) Fear 54:
   - Eyebrows are raised. Eyes are wide open.
   - Jaw dropped and Mouth is slack.
   - Overall: No tension. Face appears Open.
3) Happy 46:
   - Eyes are relaxed
   - Lips are curved up
   - Overall: Relaxed
4) Angry 51:
   - Eyes are glaring.
   - Mouth and jaw are tense.
   - Overall: Tension
5) Happy 42:
   - Eyes are relaxed
   - Lips are curved up
   - Overall: Relaxed

Similarity Characteristics Answers

Happy:

Eyes/Eyebrows: (level 3 only)
- Relaxed, lids starting to cover some of the eye

Mouth: Levels 1-7
- Curved up

Sad:

Eyebrows: Levels 1, 2, 3, and 4
- Eyebrows are knitted (raised) up in the middle

Eyes: Levels 1, 2, 3, 4, and 6.
- Eyelids are droopy

Eye Region: Levels 5 and 7 only
- Eyebrows are knitted up in the middle and/or the eyelids are droopy

Mouth: Levels 1-7
- Lips are starting to curve down or are straight across

Angry:

Eyebrows: Levels 1,2, 3, 4, 5, and 7
- Scrunched, coming down in the middle

Eye Region: Level 6 Only
- Eyebrows are scrunched down in the middle and/or eyes are glaring.

FAR Intervention

Mouth: Levels 1-7
- Tense and exposing teeth or in a tight flat line

Fearful:

Eyebrows: Levels 1-7
- Raised

Eyes: Levels 1-7
- Wide open

Mouth: levels 1-7
- Jaw dropped (slack)

D) Problem Management

i. Not able to generate events (no repeats/ day):
   1. Find out info about the participants: interests, prior or current work situation, family situation etc
   2. Refer to info provided by the family re: behavioral issues
   3. Fear: Think of fear as anxious or worried. Give them ex. of things you might be afraid of (ie. being able to pay bills, get in car accident, make a mistake at work, meeting new people, etc)

ii. Difficulty ID emotion: Make line drawings of faces and label. Compare to real faces.

iii. Not wanting to participate: (Refer to section I, Importance of Emotion Recognition for suggestions).
   1. Ask why. They might not know so try and have them get in touch with their feelings and be able to communicate why to you.
      a. Don't care: Re-iterate importance of understanding others' emotions and ways it could benefit them
      b. Don't want to think of things that stir up bad emotions:
   2. Although you don't want to encourage, they need to know they can always withdraw if they decide to (but 1st discuss above)

iv. Getting off task:
   1. Take a 2-5 minute break in the middle of session to just talk
   2. 2-5 min @ beginning and end of session just to talk.
   3. Always let them know what they are talking about is important but must stay focused.
   4. Sometimes when discussing a difficult event (even if on topic), it is hard to get them back to the program. "I know this was hard for you, so we will talk more about this later." Just be sure to be sensitive in redirecting them.

v. Time Management
   1. Running ahead of schedule:
      a. Spend more time discussing personal events.
      b. Repeat exercises the person had the hardest time with.

FAR Intervention

c. Start exercises over, only identifying emotions. Concentrate on speed. Identify emotion as fast as possible. Time them.

2. Running behind schedule:
    a. Spend less time discussing personal emotions.
    b. Only discuss 1 personal emotion per exercise. If you decide to do this, make sure to focus on Sad and Angry emotions, since they are the most difficult.

Using the Old FAR Program

Working Through the FAR Treatment Program

* Before beginning the program, state: "The purpose of this treatment is to try to help you better recognize how people are feeling. When this study is over, we hope that when you are talking or socializing with others, you will be better able to figure out how they are feeling."

FAR Intervention

Exercise 1 (Computer)

1. *Open the folder that says FAR_Program*
2. *Open the folder that says Face1TrainB*
3. *Go to toolbar and click on View→ list*
4. *Double click on Day1series1 (about 8 icons down; do not pay attention to the names)*
5. *Session 1, Series 1*

a. *Read instructions: "In this series, you will be shown faces expressing different emotions. Your task is to identify the emotion that each face is portraying." And click Start.*

6. *You may need to click the yellow bar at the top to allow blocked content and begin program.*
7. *Ask participant, "How do you think this person feels?" If they are struggling, "what should you be looking at to help you figure that out?" (eye region and mouth: point to the cues)*
8. *Have them respond (either you or them could control the mouse).*
9. *If correct ask, "How did you know? Describe features" (Appendix B for being consistent with feature description)*
10. *If incorrect, draw their attention to the feedback and have them read it out loud. If trouble reading you could read it for them and point to what the feedback is describing".*
11. *Then select correct emotion → next. Keep going in this format. It will bring you to Session 1, Series 2. The faces repeat. Tell them they could expect to see the same faces, but there are other things they must do in this section.*
12. *Read instructions for Session 1, Series 2: In this series, after you identify the emotion for each face, you will be asked to discuss a time that you remember feeling that emotion yourself or an example of an event that would make you feel that emotion. Click Start.*
13. *For this section, after the participant identifies the emotion, ask them to tell you something in their lives that made them feel that emotion. (see hints and problem solving for suggestions if you encounter problems with this). Do not let them repeat the same event within the same day. Make them work hard to give you meaningful events. Refer to Advanced Emotion Training exercises so you know what you will need to be discussing later on. Continue through program.*
14. *Session 1, Series 3 (read instructions): In this series, after you identify the emotion for each face, you will be given a mirror and asked to imitate that emotion. For this section, after they identify the emotion, have them imitate the facial expression. Remind them of events they described to you in the last series to make facial expression more genuine. Have them look in a mirror as they are doing it and give them feedback.*
15. *You will eventually get to a section that shows several faces depicting the same emotion. On the top of the page it says, "These*

FAR Intervention

people are xxx. What features do they have in common?" Go through the series of questions with them and hit "next" when you are finished with that page"

16. *The new program will then bring you to a section that requires the participant to find the face that depicts a particular emotion out of 4 faces. This is not currently in this version.*
17. *Score exercise as a whole. If less than 85%, repeat first thing on Session 2.*

Appendix H. Treatment Manual for *Stories* Intervention

Procedure Manual for

Stories Of Emotional Inference (SEI)

Dawn Neumann, Barbra Zupan, Barry Willer

Version: March 2009

SEI Intervention

Table of Contents

TOPIC	Pages
I. Importance of Emotion Recognition	3-5
II. Using the Program	6-7
III. Treatment	8-17
1. Summary	8
2. Description of the Program	8
a. Computer Based Exercises	8-10
b. Advanced Emotional Training	10-11
3. Administering the Treatment	11-17
a. Example of Potential Treatment Course	11-12
b. Using the Software for SEI (Program 2)	13-17
IV. Problem Management.	18-19
V. SEI Detailed Responses for Participants' Incorrect Responses	20-24
Appendix A. Response Sheets.	25-38

.

SEI Intervention

I. Importance of Emotion Recognition

Just like in the clinical setting, it's always good to reiterate the meaningfulness and importance of what you're working on with the participant and what you hope to accomplish. Some participants may not be aware they have a problem with affect recognition, or some may realize it, but not see the importance of it. In this study people will be asked to talk about emotionally personal events. They may not see the value of talking about their negative emotions. It's critical that you could help participants see the significance of learning to identify their negative emotions as well as understanding others' emotions.

<u>What we are working on and what we hope to accomplish</u>

"The purpose of this treatment is to try to help you better recognize how people are feeling. When this study is over, we hope that when you are talking or socializing with others, you will be better able to figure out how they are feeling."

<u>Why it's important to understand others' emotions</u>

- Help us to interact with others better (behavior)
  - If we know how people feel (spouse, friend, etc), it will help us to know how to respond to them. (sad= console; angry= apologize)
- Improve relationships
  - Develop emotional bonds. Understanding each others' emotions helps to develop a special kind of closeness in a relationship.
  - Help us to be a supportive friend, spouse, etc: We will be perceived as a supportive person if we anticipate others' emotional needs. This is a very important quality in a relationship. This is pur way to repay somebody for all of the care they have given to us. This will show our appreciation and affection.
  - Helps to show people we care about them. If we care about you, we must care about your emotions. Did I hurt your feelings? Could I ease your sadness? Etc.

SEI Intervention

- Help us to become a person people want to interact with more. People appreciate if you understand their emotions and that you are concerned about their feelings. If we know someone cares about my feelings, we are more likely to want to spend time with them than someone who doesn't care.

Why it's important to discuss and understand their emotions

- Need to experience all of the emotions to get joy out of anything. Some people don't like to think about or experience negative emotions such as sadness or anger. Some people may say, "Life is too short to be bothered". But if you don't allow yourself to experience negative emotions, it's likely you won't have the full experience of "happy" either. Your system will get used to being emotionally shut down. We need to force ourselves to feel- good or bad.

- Emotional Control: Sometimes we let emotions build up because we ignore them and then we explode. If we dealt with them as they came, we wouldn't overreact at other times.

- Understand our emotions better. By thinking about and discussing negative emotions, we may better figure out how we are truly feeling and why. Sometimes our emotions aren't always what they seem initially. Sometimes we react angry when we are really sad. We would probably have a much better outcome if we communicated sadness to someone instead of always acting angry. Also, if something caused us to feel badly we could learn to avoid what caused the feeling in the future, or communicate this to others.

- Understand others better. If we understand our own emotions, we will better relate to others and know when they are feeling a certain way. How do we want people to respond to us when we are feeling bad? Then we could respond that way to others when we see they are feeling bad.

- Help to us to communicate our needs better with others so they know what we're experiencing and how to help us. This could avoid misunderstandings and unnecessary arguments.

- Be more productive: Emotions are a motivator. If we feel passionate about something we will work on it and complete it. On the other hand, sometimes we may be expected to do something we really don't want to. If we don't do it, we will get in trouble. If

SEI Intervention

we want to avoid feeling bad- we will get it done because we don’t want the negative consequences (which will make us feel bad).

- Have better judgment and decision-making: If we know our actions and behavior may hurt someone we may decide not to do it, because we know how it feels. Or if our actions or behaviors may get us in trouble (ie. yelled at, making us feel bad) we will avoid those behaviors.

- Improve memory: The more emotionally connected we are to things, the better we will remember them.

SEI Intervention

II. General Information

Schedule:
Try to schedule appointments 1 week at a time (or more if possible), rather than 1 day at a time. Treatment needs to be 3 times a week, one hour each session.

	Sun	Mon	Tues	Wed	Thurs	Fri	Sat
Week 1							
Week 2							
Week 3							

Participants may often finish more than one story in one session. In order for the client to move on to the next story, he or she must achieve 80% accuracy when answering the questions for that story (4 out of 5 questions correct). Therefore, the client/participant must repeat any story that they are unable to achieve this 80% accuracy. If this happens, move on to the next story and then repeat the story they did poorly on at the beginning of the next session.

Training will be 1 on 1, in a quiet room. You will need a computer with speakers. Provide breaks to the participant as needed, but do try to manage your time efficiently. This could sometimes be a challenge since many participants will like to talk a lot or go off on tangents. If this is the case, set aside break time and/or at the end of the session for general chat time. It is important to do the small talk because you need to develop a rapport with the patient. The better the rapport, the more willing they will be to open up emotionally to you.

Prior to beginning the training on the first day, review the overall purpose of the program with the participant. The following script does not have to be said word for word, but the gist of the message (in the bolded words) should be communicated.

Script: "For the next several weeks we are going to read a series of stories that **should help with your ability to make social inferences.** Although the content of each story will vary, **the goals for all of the stories are to work on figuring out what the characters in the story feel, think and want.** We will also **talk about situations that have happened in your life that might be similar to the situations in the stories.**

SEI Intervention

Although you may find that are you quite good at answering the questions for the stories, you must complete each story. There are 14 altogether. For each story, you will get a score out of 5. **If you get less than 4, you will need to repeat that story** by the end of the 9 treatment sessions."

SEI Intervention

III. Treatment

1. Goals:

There are two main goals for the Stories of Emotional Inferencing Treatment program:

i. To teach participants to attend to important contextual cues in text in order to make inferences about how the character is feeling.

ii. To use personal emotional experience to relate to and identify emotions in others.

2. Description of the Program:

- There are two main components to this program. One component uses a computer to familiarize participants with facial expressions. The other piece uses elaborate discussion to help the participant relate to the emotions being discussed, through awareness of their own personal emotional experiences. Both components of this program are interwoven and require a lot of interaction between the participant and the therapist. The program also incorporates the following strategies: a) Identifying the emotion using visual cues that are eliminated over time and through descriptive feedback b) Discussing personal events that relate to the event(s) portrayed in the story just read and c) Discussing vocabulary and context that refers to similar emotions to those discussed in the story.

a. Computer Based Exercises:

There are a total of 14 stories that must be completed within the 9 treatment sessions. All stories are computer-based. Participants are able to read the text of each story while simultaneously listening to them. Each story is followed by five questions that ask about the emotional status of the characters. In order to compensate for memory limitations, questions are "hyperlinked" or connected to the relevant area of the story so that the participant may easily re-read the relevant information. After the participants respond to each question, feedback will be provided through a "pop-up" message telling the participant if he/she was correct, along with the correct response and the reason why. Whether participants' responses were right or wrong they will be asked to think of something similar that may have happened in his/her own life followed by a series of questions relating to that event.

The program is designed so that you can work within the participant's own comfortable pace. Aim to complete two stories per session to allow time for discussion and time to review any stories in which the 80% criterion was not met. You may find that participants have difficulty remaining on task during the story discussion itself. If this occurs, remind them that there will be opportunity to discuss personal situations that are similar to those occurring in the stories following the fifth and final question. Redirection of this nature is important to ensure that the participant is able to use the information in the story to make inferences about the characters wants, needs and beliefs rather than using his/her own feelings to answer the questions.

Following is a list of the 14 stories that comprise the SEI treatment program. The stories must be completed in the order listed because the level of support provided is reduced throughout the sequence. In addition, the complexity of the stories and questions increase throughout this sequence.

In stories 1-6, participants are guided in their responses of each question in the following ways: 1) Relevant text within the paragraph that pertains to a specific question is written in colour and 2) Key words within this relevant text is also bolded. In stories 7-10, key words are no longer in bold, but the relevant text specific to each question is still presented in colour. Stories 11-14 have no additional cues and are presented in regular black print only.

Story 1: You're Fired.
Story 2: Bahamas.
Story 3: A Soldier Returns Home.
Story 4: Back to School.
Story 5: Lake House.
Story 6: Model Car.
Story 7: Newlyweds.
Story 8: Parents - To - Be.
Story 9: Independence Day.
Story 10: To Be A Friend.

SEI Intervention

Story 11: Baby on Board.
Story 12: Grandma.
Story 13: College Years.
Story 14: SFPD.

b. Advanced Emotional Training (Personal Emotions)

- Activity: Discuss in detail some of the personal events that the participant mentioned during the computer-based exercises. There are 2 purposes to this section: a) to help the participant better understand what others are feeling, by first better understanding their own emotions; b) have them get in touch with the physiological changes and changes in their body state that are associated with particular emotions.

- The main ideas: To have the person know 1) how an event made them feel, 2) why it made them feel that way, 3) how their emotions made them behave or react, 4) and how were others affected by the event itself and the person's emotional reactions. There is a guideline of questions that should be used for this that are listed below as well as on the response sheet. However, this guideline can be varied somewhat to fit the event being discussed. Feel free to ask additional questions to get more feedback from the participant. Also, if the question is not appropriate for the event being discussed, you may skip it or alter it so that it is more appropriate. As you are having the discussion with the participant, do not let them go too far off on a tangent. Keep them focused on the task at hand. However, if the conversation is productive, you have the time, and you are addressing the key goals (stated above), you could continue the discussion. Conversations should usually last around 15 to 20 minutes *(This is not very evident from the training DVD due to time constraints)*. If you are talking about a negative emotion, always end with a positive outcome from that event.

- Sample of General Discussion guideline*: (See response sheets for detailed questions for each specific emotions)*

"The story we just finished reading was about…". I want to talk more about that event and discuss any similar event that happened in your life.

a) Have you ever had anything similar happen in your life?
b) Can you describe that for me?
c) What led up to the event?
d) How did the event make you feel? You may have felt several different emotions. What was the strongest emotion you felt? _________ (should be happy)

SEI Intervention

e) Describe how that made you feel inside (heart rate, muscle tension)? What feelings are usually associated with "happiness"? _______
Help the participant out if need be by using the examples listed in the following section (Examples are also listed on a separate page for easy reference).
f) Did this event make you feel any other emotion? If yes, describe. ___________________________
g) Why do you think you felt the emotion(s) you did?
h) What were the consequences/outcome of the event?
i) How did you respond to the event or what was your reaction or how did you act (whatever is appropriate for the event being discussed)
j) How do you think others who were involved felt and why?

- Description of typical body state/ physiological changes associated with the different emotions. As you are discussing events and emotions with the participants, use the descriptions provided below to illustrate how certain emotions "feel".
    - Happy: swelling feeling in chest; muscles relaxed; sensation of buoyancy or lightness as if standing underwater.
    - Sad: heaviness in chest, arms and legs; tightness in throat and eyes. Eyelids knitted, lids lowered, corners of mouth downward.
    - Anger: Increased muscle tension in neck, shoulders, arms, legs; increased heart rate. Eyebrows scrunched,teeth/ jaw line clenched due to overall increase in tension.
    - Fear: Increased muscle tension **or** muscles become weak/ jello/rubbery. Heart races. May become jumpy or jittery. Butterflies in stomach. Eyes wide open. Eyebrows raised, jaw slack.

3. Administering the Treatment

a. Example of Potential Treatment Course:

The program is designed to work at the pace of each individual participant. Participants may not always complete two stories per session and may need to repeat. For that reason, the following table is meant to be a guideline on how to progress through the program.

SEI Intervention

	Task 1	Task 2
Session 1	Review what the program is about.	Complete Story 1 and Story 1 questions. Complete questions relating to personal experience.
Session 2	Complete Story 2 and Story 2 questions. Complete questions relating to personal experience.	Complete Story 3 and Story 3 questions. Complete questions relating to personal experience.
Session 3	Repeat Story 3 and Story 3 Questions. Complete questions relating to personal experience.	Complete Story 4 and Story 4 questions. Complete questions relating to personal experience.
Session 4	Complete Story 5 and Story 5 questions. Complete questions relating to personal experience.	Complete Story 6 and Story 6 questions. Complete questions relating to personal experience.
Session 5	Repeat Story 5 and Story 5 Questions. Complete questions relating to personal experience.	Complete Story 7 and Story 7 questions. Complete questions relating to personal experience.
Session 6	Complete Story 8 and Story 8 questions. Complete questions relating to personal experience.	Complete Story 9 and Story 9 questions. Complete questions relating to personal experience.
Session 7	Repeat Story 9 and Story 9 Questions. Complete questions relating to personal experience.	Complete Story 10 and Story 10 questions. Complete questions relating to personal experience.
Session 8	Complete Story 11 and Story 11 questions. Complete questions relating to personal experience.	Complete Story 12 and Story 12 questions. Complete questions relating to personal experience.
Session 9	Complete Story 13 and Story 13 questions. Complete questions relating to personal experience.	Complete Story 14 and Story 14 questions. Complete questions relating to personal experience.

SEI Intervention

b. Using the Software for SEI (Program 2)

Step One:
At the beginning of session one, it is important to review what the treatment program is about with the participant. You can use the script provided at the beginning of this manual.

Recall:

The following script does not have to be said word for work, but the gist of the message (in the bolded words) should be communicated.

Script: "For the next several weeks we are going to read a series of stories that **should help with your ability to make social inferences.** Although the content of each story will vary, **the goals for all of the stories are to work on figuring out what the characters in the story feel, think and want.** We will also **talk about situations that have happened in your life that might be similar to the situations in the stories.** Although you may find that are you quite good at answering the questions for the stories, you must complete each story. There are 14 altogether. For each story, you will get a score out of 5. **If you get less than 4, you will need to repeat that story** at the beginning of the next treatment session."

Ask the participant if he/she has any questions and then you may begin with Story 1.

Step Two:
There is a shortcut on the computer desktop labeled IMOLE Student. You will need to double click on this shortcut to access the FAR and SEI treatment programs.

Step Three:
When the IMOLE program opens, it will bring you to a main menu that has two listings: Program 1 and Program 2. This is the Course Menu. The SEI Intervention is Program 2. Click once.

-------*Insert pic here*----------

Step Four:
This will bring you to a second page, the Chapter Menu, that has two listings: 1) SEI Procedures which is a link to this procedure manual and

SEI Intervention

2) Program 2: Stories of Emotional Inferencing (SEI) which is a link to the stories. Click Program 2 once.

-------*Insert pic here*----------

Step Five:
You will see the stories listed here in order. Single click on the story you need. Begin with Story 1 in Session 1 and then work through the stories in order. You will only need to do a story out of order, if the participant needs to repeat an earlier story in the following session because they had less than 4 answers correct on the story questions.

-------*Insert pic here*----------

Step Six:
You will now see a title page for the story. You can review the title with the participant and then click the forward arrow button to start the story.

Step Seven:
Each page contains one paragraph of the story. Above the text box that contains the paragraph, you will see a 'Play' arrow. Click this arrow to begin the auditory segment that matches the paragraph shown.

When the audio has completed for that paragraph, click the forward button to move to the next paragraph in the story. Again, click the play button to start the audio for this next portion. Continue to do this until you reach the end of the story and the beginning of the questions.

-------*Insert pic here*----------

Step Eight:
Read Question 1 with the participant. The participant may want to immediately provide an answer. However, click on the HINT button which will open a text box to the right that contains the relevant paragraph and text from the story. Have the participant re-read the text prior to giving a response. You can press the play arrow to re-play this section of the story but during the initial stories, you may tell him/her to pay particular attention to the coloured and bolded text within that box.

------ *Insert pic here*----------

Step Nine:
Have the participant give you the response orally. You will then click on the response using the options on the left below the question. Ask the participant why he/she chose that response. Talk about the specific

SEI Intervention

events and behaviours in the story that led him/her to make that choice. Talk about what the character expected/wanted and discuss if the events were consistent with those expectations/wants.

Step Ten:
If the participant is incorrect, a pop-up text box will open that indicates that the response chosen is incorrect. Review this feedback with the participant by having him/her read it out loud or read it out loud for them. Click OK to make this box disappear.

Once the feedback box disappears, another text box will open on the right over the original Hint text box. This pop-up text box provides information regarding which cues/phrases the participant should have used to make his/her choice. Discuss this information with the participant and highlight the key words and behaviours. Then discuss the character's wants and expectations and whether what happened was consistent or inconsistent with those wants and expectations. Also discuss the events and behaviours that occurred in the story that may also have provided clues. In addition, ask if particular phrases or words provided led the client/participant to choose a particular emotion. Summarize participant's responses to these discussion questions. Record them on the response sheet in the column titled, "List Keywords & ID event, behavior, consistent with want/ expectation". Go back to the question and ask the client/participant to provide the response. Click on the response.

------ *Insert pic here*----------

If the participant is correct, a pop-up text box will come on screen that indicates this. Provide praise and ask them how they knew this was the correct answer. In other words ask them to report to you which key words/information led him/her to choose that response. Reinforce this information by clicking on the HINT button and going back and reviewing the text. Explicitly discuss the clues that led to this response (i.e. events, behaviours, consistent/inconsistent with character's wants or needs). Summarize participant's responses to these discussion questions. Record them on the response sheet in the column titled, "List Keywords & ID event, behavior, consistent with want/ expectation".

------ *Insert pic here*----------

Step Eleven:

SEI Intervention

Record the original response on the response sheet by circling H, S, A or F. In the box next to that, write some of the words down that the participant provided to describe the event and behaviours.

16

SEI Intervention

Step Twelve:
Once the participant has completed question 5, click the arrow at the bottom of the screen to move to the next page in the program. You will see a screen that says 'Advanced Emotional Processing'.

------ *Insert pic here*----------

Regardless of whether the participant was correct/incorrect, or achieved 80% or not, you will complete the Advanced Emotional Processing portion of the program with the participant at the end of each story. Do this by reviewing the following questions with the participant. These questions are designed to relate the story to events in the participant's life. However, use them as a guideline. It is important that the discussion flow naturally.

a. Has anything similar ever happened to you?, If so, please describe.
b. How would you have felt in this situation (or how did you feel in your similar situation)? Why did (or would) you feel that way?
c. How did (would) you respond in the event?
d. What was (or do you think) the outcome of the event (would be)?
e. How do you think the event and/or your actions made (would make) others feel;
f. What makes you think they felt that way?

Step Thirteen:

Record the participant's responses on the response sheet for each of the above questions.

Step Fourteen:

Move onto the next story and repeat the process. If you are moving onto another story within the same session, you can just click the forward arrow and the program will automatically move you to the next story.

SEI Intervention

If you are beginning a new session, repeat the steps listed above beginning with Step Two. Once you reach Step Five, single click on the story you need to begin with.

Step Fifteen:

Scoring: The participant needs to get 4 out of 5 questions correct in order to successfully complete a story. If he/she achieves fewer than 4 correct responses, then the story will need to completed a second time in the following session. Refer to Potential Treatment Course on Page 12. No matter what the person's score (pass or not), you will go to the Advanced Emotional training.

SEI Intervention

IV. Problem Management

1. Participant is not able to generate an event following the story (no repeats/ day):

    - Find out info about the participants: interests, prior or current work situation, family situation, etc.
    - Refer to info provided by the family re: behavioural issues
    - Fear: Think of fear as anxious or worried. Give them examples of things you might be afraid of (i.e. being able to pay bills, get in car accident, make a mistake at work, meeting new people, etc.)

2. Not wanting to participate: (Refer to section I, Importance of Emotion Recognition for suggestions).

    - Ask why. They might not know so try and have them get in touch with their feelings and be able to communicate why to you.

        a. Don’t care: Re-iterate importance of understanding others’ emotions and ways it could benefit them

        b. Don’t want to think of things that stir up bad emotions:

    - Although you don’t want to encourage, they need to know they can always withdraw if they decide to (but 1st discuss above)

3. Getting off task:

    - Take a 2-5 minute break in the middle of session to just talk
    - 2-5 min @ beginning and end of session just to talk.
    - Always let them know what they are talking about is important but must stay focused.
    - Sometimes when discussing a difficult event (even if on topic), it is hard to get them back to the program. “I know this was hard for you, so we will talk more about this later.” Just be sure to be sensitive in redirecting them.

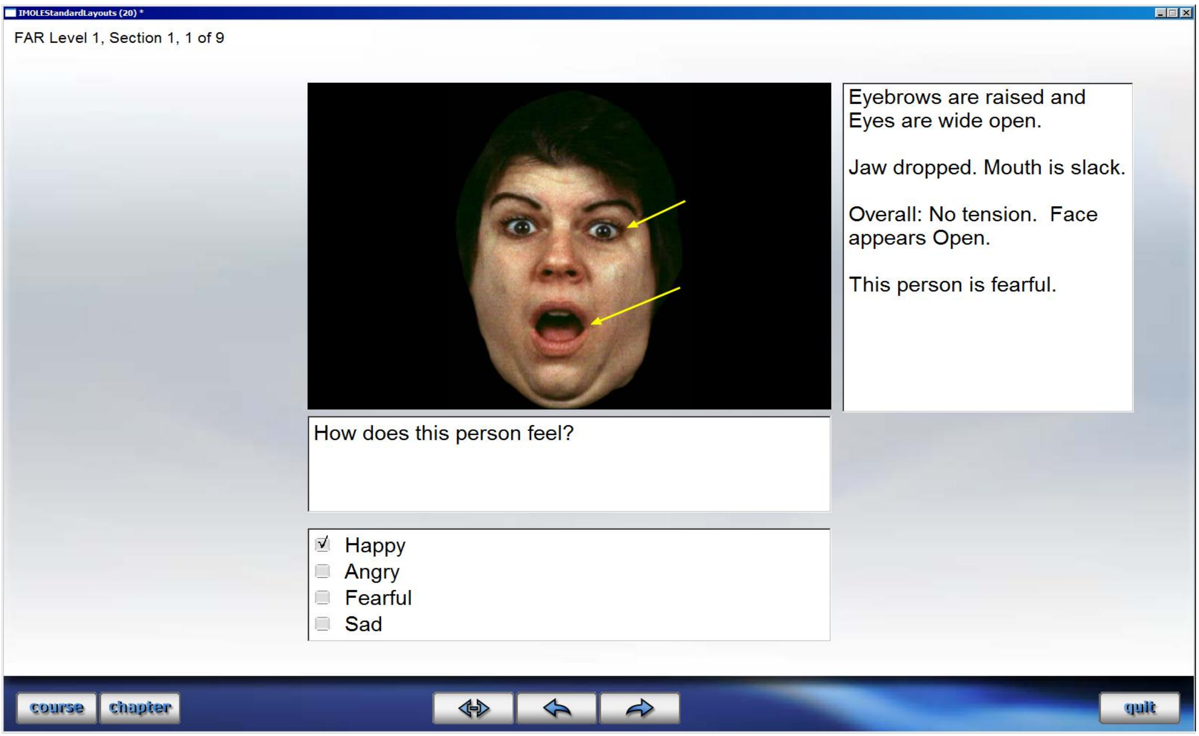
SEI Intervention

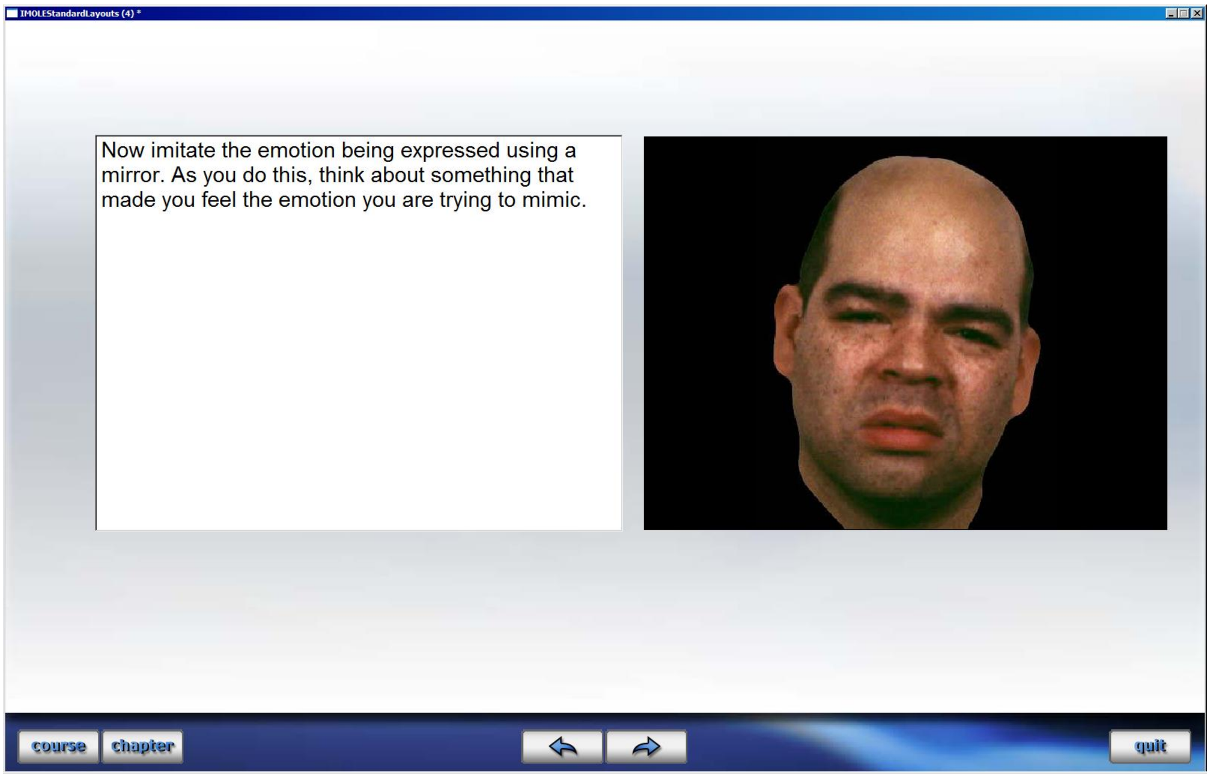
4. Time Management

- Running ahead of schedule:
  a. Spend more time discussing personal events.
- Running behind schedule:
  b. Spend less time discussing personal events.

20

Appendix I. Part 1 of the *Faces* Training





Appendix J. Part 2 of the *Faces* Training

Advanced emotional training

Instructions: We are going to spend a little more time discussing some of the personal situations you brought up when we were doing the computer exercise. When we are discussing these things that happened, I want you to try to put yourself back into the situation. I want you to recall it as vividly as possible and try to feel what you 'felt' at the time of the situation. When you were sad, you may have felt heavy and tired as if weights were pulling you down and making it hard to breathe. When you were angry, you may have felt tense and your heart rate may have speed up. I want you to try to 'feel' these type of feelings again."

Situation: SAD ____

"Earlier we talked a little bit about….(situation listed above). Let's spend more time discussing it."

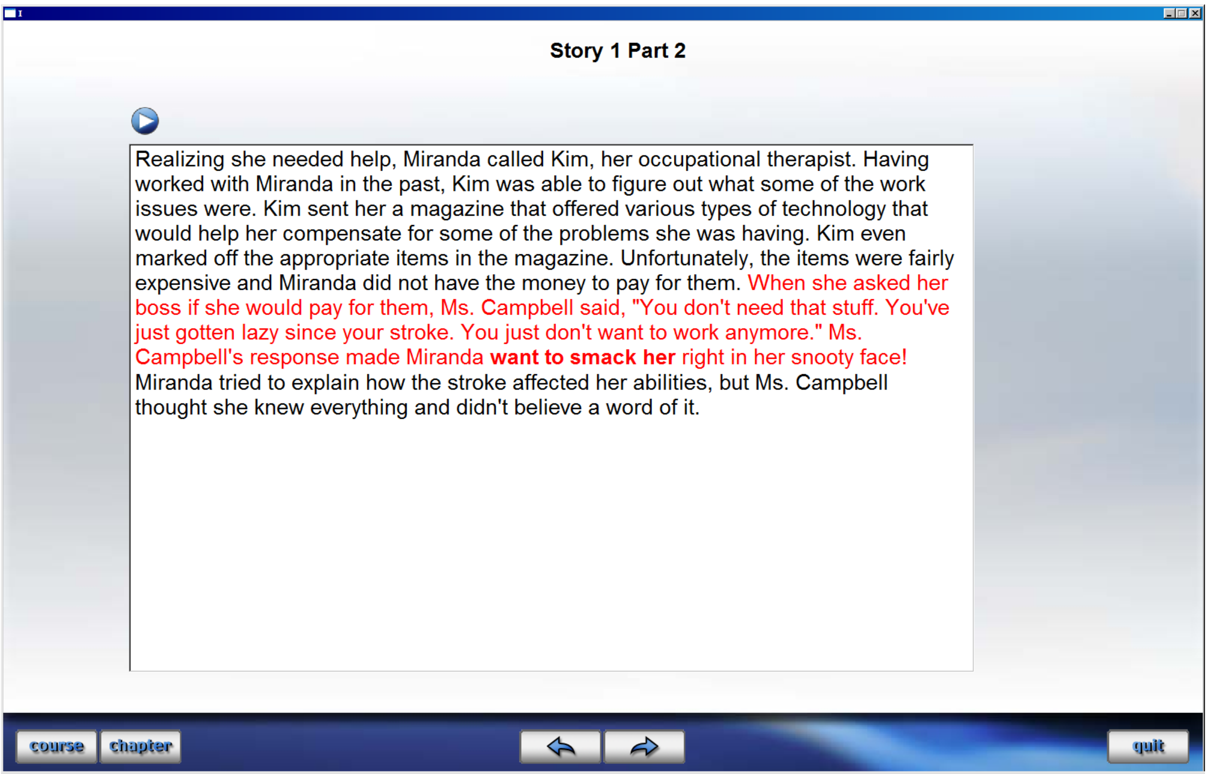
Situation: ANGRY ____

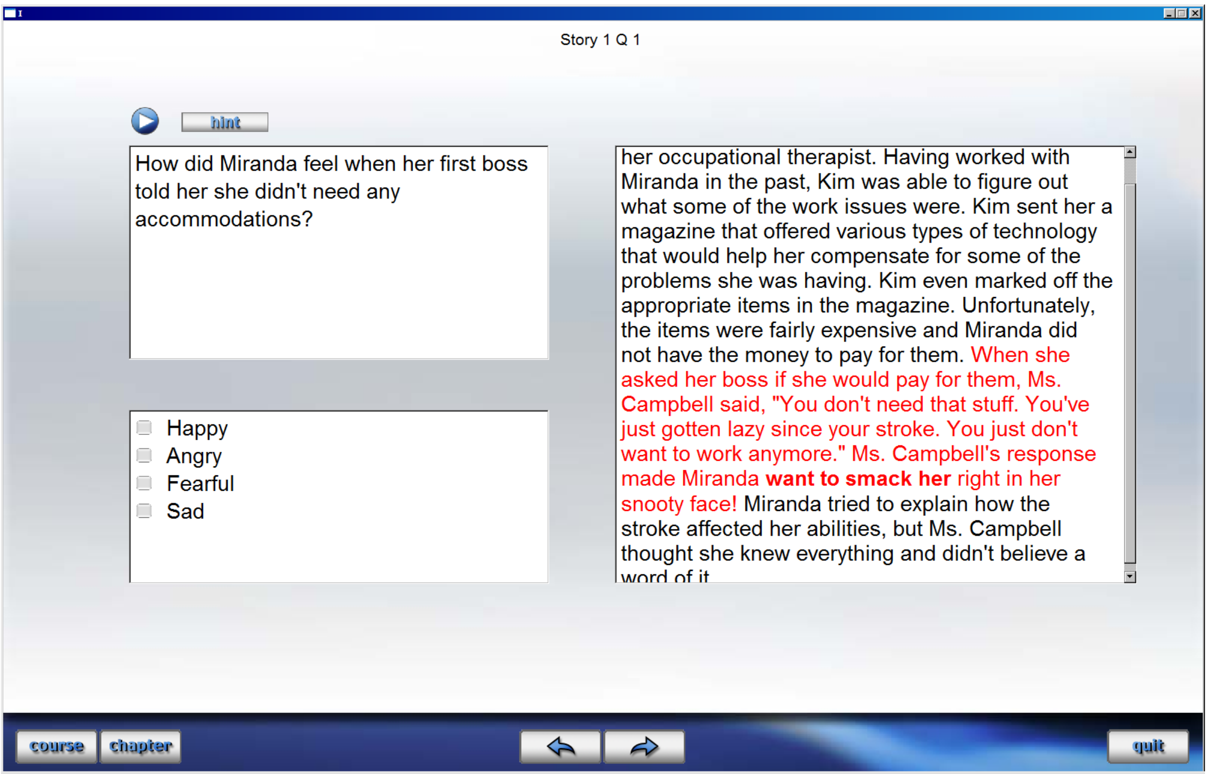
1. Description of the situation (s)
2. How the participant felt (all emotions)
   - Label (angry, sad, etc)
   - Show 8 faces on computer
   - Physiological description
3. Reason for emotions (I was angry because…, but I was also sad because….. etc).
4. Response to the situation
   - Behavior
   - Emotion outwardly expressed by the participant (face)
5. Other's perception of their emotion (Based on the participants' response, what does the participant think others thought that he or she (the participant) was feeling?)
6. Other's response (How did others in the situation respond to your behavior?)
   - Their facial expressions
   - Their behavior
7. Other's feelings (How do you think they were feeling based on facial expressions and behavior)
8. Why they think others were feeling that way- why would they feel that way?

	Happy	**Sad**	**Angry**	**Fearful**
Muscles are…	Relaxed	Heavy, as if a weight is on your chest.	Very tense.	
Heart rate…	Low and normal	May be slow (or fast if anxious too)	Speeds up.	Speeds up.
Feel like…	Floating in air or on water, Tingly.	Lacking in energy; tired; weighed down	Tense and tight; hot as if temperature rises; may want to hit something or yell and scream.	Stomach has butterflies; Sweating and shaking; Feel on edge or jumpy.

NOTES:

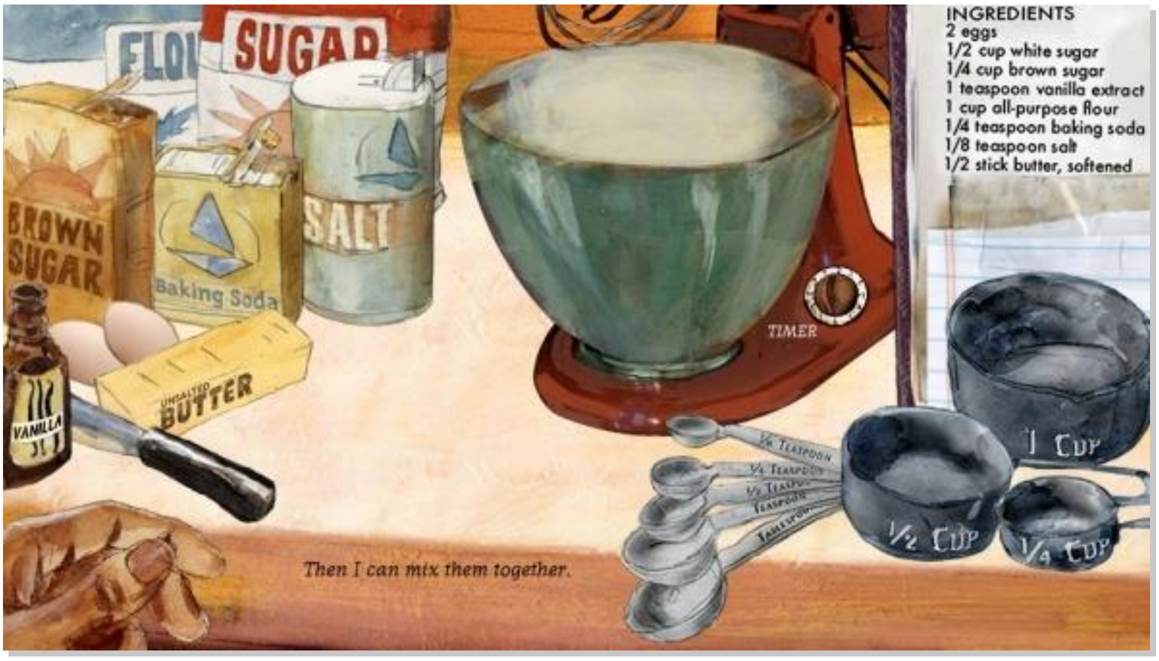
Appendix K. *Stories* Training (Story 1)





Appendix L. Cognitive Training

A. GCF LearnFree.org



B. Cognitive Labs